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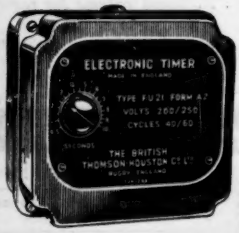


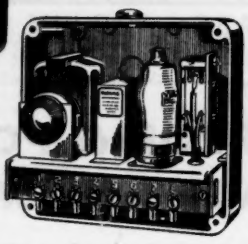

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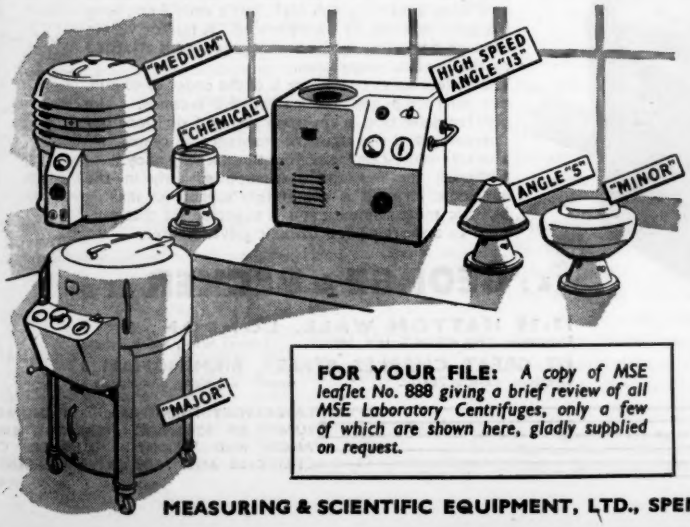


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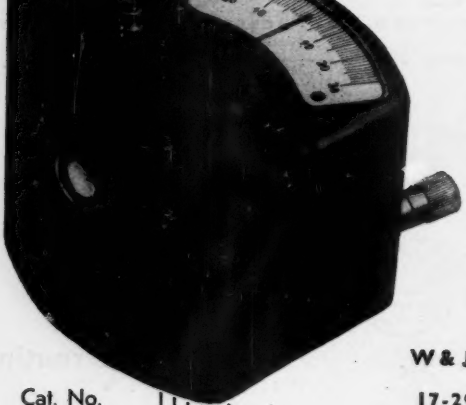

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# NATURE

No. 4269 SATURDAY, AUGUST 25, 1951 Vol. 168


## CONTENTS


| | Page |
|---|---|
| Freedom of Speech and Thought | 305 |
| The Story of English Farming. By Sir John Russell, F.R.S. | 307 |
| Contributions to Mathematical Statistics. By Dr. F. Yates, F.R.S. | 308 |
| Pollen Analysis. By Dr. J. B. Simpson | 309 |
| American Deciduous Forests. By Sir Edward Salisbury, C.B.E., F.R.S. | 309 |
| Civil Administration in Great Britain. By R. Brightman | 310 |
| A Hundred Years of Plant Morphology. By Dr. H. Hamshaw Thomas, F.R.S. | 312 |
| Geography in the Service of Mankind. By E. O. Giffard, M.B.E. | 314 |
| Variations in Brood-strength in the North Sea Haddock, in the Light of Relevant Wind Conditions. By Dr. J. N. Carruthers, Commander A. L. Lawford, R.N. (ret'd.), Instructor-Lieut. V. F. C. Veley and B. B. Parrish | 317 |
| News and Views | 319 |
| Egg-shell Formation in Trematodes and Cestodes as demonstrated by the Methyl or Malachite Green Techniques. By Dr. J. D. Smyth | 322 |
| Effects of a Protein-free Diet on the Alkaline and Acid Phosphatase Activity of the Liver of the Rat. By J. O. Ely and M. H. Ross | 323 |
| Optical Rotation and Chain Folding in Synthetic Polypeptides and Gelatin. By Dr. Conmar Robinson and M. J. Bott | 325 |
| A Hundred Years of Organic Chemistry (1851–1951) | 326 |
| Vertical Migration of Plankton Animals | 327 |
| Applications of Plastics. By H. V. Potter | 328 |
| Library Service in Great Britain: Annual Conference of the Library Association | 329 |
| Research on Brick-making: New Research Laboratories of the London Brick Co., Ltd. | 331 |
| Letters to the Editor: | |
| Mode of Action of Antibiotics in Stimulating Growth of Chicks.—M. E. Coates, C. D. Dickinson, G. F. Harrison, Dr. S. K. Kon, Sheila H. Cummins and W. F. J. Cuthbertson | 332 |
| A 2:4-Diamino Pyrimidine in the Treatment of Proguanil-resistant Laboratory Malarial Strains.—I. M. Rollo | 332 |
| Formation of Extra-cellular Nitrogen Compounds by Fungi.—A. G. Morton | 333 |
| Photo-inactivation of the Plant Hormone Indoleacetic Acid by Fluorescent Substances.—Dr. Mario G. Ferri | 334 |
| Protection by Receptor-destroying Enzyme against Infection with a Neurotropic Variant of Influenza Virus.—H. J. F. Cairns | 335 |
| Inhibitory Action of Artificial Light on the Sexual Season of the Ewe.—E. S. E. Hafez | 336 |
| Control of Cauliflower Mosaic Virus.—J. G. Jenkinson and G. D. Glynne Jones | 336 |
| Relationship of Aphid Density to Altitude.—C. G. Johnson and H. L. Penman | 337 |
| Chromosome Number and Chromosome Morphology in *Helicophyllum crassipes*.—Miss Thoraya Lotfy | 338 |
| Nitrogen Nutrition of Clover.—J. T. Vantsis and Dr. G. Bond | 339 |
| Body-Temperature of Small Insect Larvæ.—F. L. Waterhouse | 340 |
| Structure of Synthetic Polypeptides and Proteins.—Dr. C. H. Bamford and W. E. Hanby | 340 |
| Viscosity of Sodium Thymonucleate.—Dr. Sadhan Basu | 341 |
| Effect of Shear's Polysaccharide on Plasma Clotting.—Sylvia Most | 342 |
| Surface Tension of Liquid Metals.—Dr. R. A. Weale; Dr. S. W. Smith, C.B.E. | 343 |
| Discontinuities in Supercooled Ionic Melts.—Dr. N. N. Greenwood and R. L. Martin | 344 |
| Dimensions of the Nitrite Ion.—Mrs. M. R. Truter | 344 |
| Ocular Scanning and Depth Perception.—J. Adamson | 345 |
| Absorption of Sound in Aqueous Solutions of Electrolytes.—K. Tamm and G. Kurtze | 346 |
| Recent Scientific and Technical Books | Supp. iii |



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## FREEDOM OF SPEECH AND THOUGHT

IN a recent lecture at the University of Manchester, Prof. W. Gellhorn, of the Columbia University School of Law, stated that there are now more physicists working on the atomic bomb project than existed in the United States a generation ago. The true significance of the position disclosed in his book "Security, Loyalty, and Science"* is only to be appreciated in the light of such a statement, at least so far as science is concerned. It is on the physicists, and especially on those concerned with nuclear physics, that the full impact of the security policies and the 'loyalty order' falls in the United States; and although Dr. Gellhorn addresses himself essentially to an American public, he has overseas readers in mind, and especially the effects of the situation on scientific advance generally. Other scientific workers, too, are obviously likely to be affected, especially by the loyalty order as at present administered; but in the main the security measures should chiefly affect physicists.

The book is one of a series of studies being made in the United States, under the general direction of Dr. R. E. Cushman of Cornell University, assisted by a grant from the Rockefeller Foundation, of the impact on civil liberties of the current measures taken by the United States Government to ensure internal security and to expose and control disloyal or subversive conduct. Much of the book is a factual summary of the way in which such measures are operated; but their effect on individuals and on scientific and national interests generally is assessed fairly on the assumption that national security may sometimes require restriction of some traditional liberties. Here Prof. Gellhorn's comments and conclusions have an interest that is not confined to the United States, and although there is little indeed in his book that has not already been expressed in discussions on freedom of science, security and loyalty in Great Britain during recent years, his argument may well prove as useful here as in the United States in a debate that is not yet concluded.

It is indeed a depressing reflexion that so much intellectual effort should be at this time diverted into the examination of such issues. This is not to doubt the justification for such an excellent statement of the real issues as Prof. Gellhorn has given us: indeed, if his argument achieves the revision of the loyalty programme and of the present personnel security procedures in the United States which he recommends, it should more than repay the time spent. There is no more striking feature in the book than the revelation of the appalling waste of administrative man-hours in such measures, with all the inquiries involved, to such little tangible purpose, even when we ignore what may be termed the secondary effects on recruitment and the quality of scientific work. As a demonstration of how not to seek security, this account of policy and practice in the United States deserves wide reading in Great Britain.

* "Security, Loyalty, and Science." By Prof. Walter Gellhorn. Pp. ix+300. (Ithaca, N.Y.: Cornell University Press; London: Oxford University Press, 1950.) 24*s.* net.

To the British reader the book is valuable particularly for the balanced survey it gives of the factors that should be taken into account in determining security policy or measures, and for the clear warning it gives of the price which may be paid for a security which in the end is illusory. Prof. Gellhorn makes two points very clear. Security is relative rather than absolute, and it is to be achieved by positive and not by negative means. Scientific and technical excellence is the foundation of national strength and security in this field, and if the measures by which it is sought to prevent a potential enemy from learning of developments impede scientific and industrial advance unduly, the price may be too high. Weaknesses and insecurity rather than security may result.

Prof. Gellhorn directs attention to a third characteristic of security measures. The indirect effects which may be the most far-reaching in their consequences are rarely immediately apparent. The effect on the quality of recruits for the fields of work affected, whether in Government service, in industry or in the universities, is cumulative and long-term rather than immediate. It may be a decade before there is decisive evidence that the most original and creative minds are reluctant to undertake work in such fields where their initiative is restricted and freedom of publication is limited; still more so if not only they but also those related to them are subject to searching inquiries of the type which Prof. Gellhorn describes as conducted either in 'security clearance' or under the 'loyalty programme'. The evidence offered in this book is sufficient to justify uneasiness on this count; the effect of restraint on freedom of publication on the quality of research and the rate of scientific advance had received impressive demonstration before the Second World War.

On the present scale of atomic energy research, the possibility, not to say probability, of wasted effort is considerably enhanced, and Prof. Gellhorn rightly directs attention to the importance of this factor now that even in the United States it is realized that the available scientific and technical man-power is limited. Though the scale of research is less in Great Britain, it would appear from the debate on Lord Cherwell's motion in the House of Lords on July 5 that misgivings as to the effective use of such resources are already entertained. Lord Cherwell was concerned primarily with the present administration under the Ministry of Supply, and argued that this is unsuited to the type of development work required: Civil Service methods are not adapted to the flexibility and the rapid decisions and assumption of responsibility which are necessary. Moreover, rightly or wrongly, many of the best engineers and scientific workers are not attracted by Civil Service conditions, and the present arrangements give the security officers an almost impossible task. Nothing that Lord Alexander said in his reply really met Lord Cherwell's arguments, and the admittedly weak Treasury control destroys the only substantial reason for continuing the present arrangement and not transferring the whole project to some special organization of the public corporation type outside the Civil Service system.

Lord Cherwell's motion was carried against the Government, but Lord Alexander's remarks on the security question indicate that in spite of his doubts as to the appropriateness of a special or semi-Government corporation for handling the atomic energy project in Great Britain, there is little risk that the Government will be stampeded into fresh security measures comparable with those in the United States. Prof. Gellhorn, indeed, goes so far as to suggest that the cost of security has proved so high that the time is ripe for considering whether the loyalty order should be expunged.

Prof. Gellhorn's chapters on the balance sheet of secrecy, the proper limits of secrecy and the universities and security searches, form the core of his book; but there is one further and wider aspect of which account should be taken. This is discussed in a chapter on the need for fair procedures, and more briefly in his concluding chapter. The problem of security cannot be dismissed without account of the issue, not simply of individual freedom but also of justice. It is part of that wider issue of our time, and for this reason Gellhorn's book may be appropriately placed by the side of a collection of essays by Mr. Charles Morgan which has been published under the title of "Liberties of the Mind"*.

The common thread running through Mr. Morgan's several essays is the theme of liberty, the threat to liberty and the techniques by which the tradition of liberty is undermined. As Prof. Gellhorn shows in his book, even if national policies on secrecy in scientific matters are intelligently formulated—as, in fact, he believes they have been in the United States—they are liable to be applied inflexibly and unintelligently, unless regard is paid to the wider issues involving simple human justice. No element is so liable to be disregarded as a result of popular pressures, and such popular pressure commonly arises from misconceptions as to the nature of scientific knowledge or the real issues at stake. Prof. J. L. Stocks once observed of social philosophy that when men do not know the faith by which they live, they will be apt inadvertently to betray it, and the remark is equally true in this matter of freedom of thought and utterance.

With the exception of the introductory essay on "Mind Control" Mr. Morgan's essays have appeared before; but the gist of the book is contained in that essay and in the Zaharoff Lecture on "The Liberty of Thought" which follows it. In the first, Mr. Morgan develops the theme that liberty is now endangered in the mind itself. He analyses frankly the implications of the Soviet, the Mindszenty and other trials with their inexplicable 'confessions'. He suggests that a new technique is emerging which will enable any unscrupulous totalitarian government to 'possess', in the scriptural sense of the word, the minds of their subjects. Mr. Morgan does not suggest that this is an entirely new development. He sees it foreshadowed in the mid-Victorian era, and detects in Tennyson's

* "Liberties of the Mind." By Charles Morgan. Pp. viii+252. (London: Macmillan and Co., Ltd., 1950.) 12s. 6d. net.

"Sixty Years After" a consciousness of what was happening. Nevertheless, although he notes the tendency of the mind to surrender more and more of its liberties, Mr. Morgan seems inclined to attribute rather too much to overt attack, and attaches too little weight to the forces in contemporary life which, by weakening individuality and initiative and undermining the faith of the individual in the validity of his own mental processes, make him the easier prey of totalitarianism. We cannot continually, by precept and practice, contemn the virtues of individualism and extol the advantages of uniformity and conformity, and at the same time expect individuals to resist more effectively the attacks on their liberty, whether direct or indirect.

It has to be recognized that, in the welfare State, there is the danger that levelling down rather than levelling up standards may induce a uniformity and lack of enterprise which are fatal to creative work and the continuing advance of mankind. That danger was clearly recognized, for example, by Lord Beveridge, in his original report on social insurance as well as in the later one on "Voluntary Action". The preservation of the 'growing points', in science, art, technology, or indeed in government, is of vital importance to a democracy, and both books direct attention to ways in which this is threatened.

In his essay on mind control, Mr. Morgan perhaps raises more fundamental issues, though he scarcely goes deep enough, and its value is rather as a challenge or stimulus to thought than as an exposition of how to avoid the danger. Some of the issues he raises are of peculiar interest to the scientific worker: he makes clear, for example, how acute the question of the right use of science has become, and how important it is for men of science to address themselves to the questions of professional ethics, before their professional as well as individual influence is undermined. That in itself may involve questions of organization or the mechanics of government, which are discussed more fully by Mr. Morgan in his following essay on the liberty of thought. Here, however, while fully as challenging, Mr. Morgan is inclined to overstate his case: he makes it plain that we can no longer take for granted much that we have been accustomed to accept from the days of Milton or earlier—we have now to be prepared to defend freedom at and from its source. But it does not follow that the dangers to democracy inherent in our present constitution are quite so serious as he suggests, or that the House of Commons is in the least likely to commit the excesses which are plainly within its power. He may underrate the restraining influence in Britain of the climate of opinion or the political tradition; but it is well that we should be reminded that the danger is there, that freedom is something to be safeguarded by our own efforts and determination. Liberty will perish, wrote Montesquieu, "when the legislature becomes more corrupt than the Executive", and we cannot watch without concern processes which weaken the sense of responsibility of either elected or elector.

In dealing with the mechanics of government, Mr. Morgan is, in fact, less convincing than Lord Justice Denning in his lectures "Freedom under the Law"; but none the less, the issues are made clear and some of his suggestions are parallel with those recommended by Prof. Gellhorn. He notes the questions involved in security against external attack, whether by armed forces or by enemy infiltrations which operate against the mind. He insists not only on the need for preventing intimidation of minorities, but also subversive intimidation by minorities. Liberty of thought, he suggests, has to be disengaged from the philosophical background of jurisprudence and made cognizable by positive law.

This challenge to intellectual leadership cannot be disregarded by scientific and other professional workers. The real danger to freedom of thought or utterance and all that Mr. Morgan understands by liberties of the mind lies really in just that indifference which enables the ill-disposed to seize institutions and prostitute them to evil purposes. Upon those liberties depend the functioning of every creative activity of mankind, in science, art and in every other field. Whether or not those dangers are exaggerated, the threat is real enough and Mr. Morgan sets it in the right context. Those who are concerned primarily with the advance of science must join forces with all who are concerned in safeguarding the liberties of men's minds and so strengthening the ramparts which defend such freedom. As Mr. Morgan writes: "There is no greater need than the world's need for a creative pause in which men shall have liberty to build and to preserve".

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## THE STORY OF ENGLISH FARMING

### English Husbandry

From the Earliest Times to the Present Day. By Robert Trow-Smith. Pp. 239+16 plates. (London: Faber and Faber, Ltd., 1951.) 18*s*. net.

IN spite of its extraordinary interest, the history of English agriculture has attracted little attention from professed historians. The great classic "English Farming" by Lord Ernle first appeared in 1912: it was last re-issued in 1936 when Sir Daniel Hall added a chapter; but it is now out of print. A revision is under consideration of the Royal Agricultural Society and the publishers and will, it is hoped, soon be undertaken; meanwhile, the advanced student has no big general treatise to work on. Dr. and Mrs. Orwin's short history is admirable for the general reader and their larger works for the advanced student, especially for those interested in the land usage. So far no similar histories have been available dealing with the development of farming technique.

The author sets out to supply this. He starts right at the beginning with the advent of the first agricultural colonists, the Neolithic peoples who about 2400 B.C. came to Britain, bringing with them the seeds of wheat (incidentally, apparently some of its associated weeds also) as well as cattle and sheep, descendants of which can still be found in outlying parts of the country. Then comes a short account of the Romano-British period, of the agriculture of which, however, little is known, though it must have been fairly efficient to maintain a relatively

large population of military and towns-people. A chapter follows on the Saxon period in which the author revels—rightly so, as they were true sons of the soil: the vast majority of the villages in the central and southern parts of England have Saxon names and were presumably founded by them, being cut out from the primeval forest, though how exactly this was done is not known. By the time of the Domesday survey, however, English agriculture was already highly developed.

From Norman times onward the picture is much more complete: Mr. Trow-Smith has cast his net widely and has an eye for picturesque detail. He points out that in the Middle Ages more of the grain produced in England was drunk than was eaten. He recalls the story of the thirty canons of St. Paul's who, in 1286, were said to have drunk two-thirds of the brew from 175 quarters of barley, 175 quarters of wheat and 720 quarters of oats—apparently averaging 1,500 gallons of ale apiece in the year—33 pints a day. One can only add, adapting one of Mr. Churchill's crisp phrases: "Some canon, some thirst".

Written accounts of English agriculture begin in the early part of the thirteenth century with Walter of Henley's "Husbandry", two anonymous treatises, and Bishop Grosseteste's "Rules" of about 1240. They were published in 1890 with a translation by Elizabeth Lamond and a description by Mr. Cunningham, and are liberally drawn upon by the author. Then followed the time of plagues and pestilences culminating in the Black Death of 1348, which greatly reduced the numbers of farm workers: recovery, however, seems in many places to have been rapid, suggesting that there had previously been a good deal of redundant labour in the villages, as often happens in peasant communities. The changes resulting from the subsequent decay of the manorial system and the long series of enclosures are well described, and the author then deals with the great developments of the seventeenth century.

During the Civil Wars some Royalist landowners went as refugees to Flanders, where they saw agricultural practices much in advance of anything they had known in Britain—in particular the culture of clover, sown grasses and other fodder crops that enabled livestock husbandry to be fully integrated with arable husbandry: this forms the basis of some of our best modern systems. The author gives numerous quotations from contemporary writers and a good selection of illustrations showing the implements they used. He emphasizes the fact that ley farming, new to some of this generation, was introduced in Britain in the seventeenth century.

The author rather condemns the high farming of the mid-nineteenth century because it relied for its success on oil cakes and meals got from overseas countries "at the expense of the fertility of foreign soils, and many parts of an eroded world are to-day paying the piper for the tune played at the call of the English mid-Victorian yeoman". This is scarcely fair. The overseas farmer had not taken up land at the behest of the mid-Victorian yeoman but in order to live: not wishing for a low-level subsistence farming, he produced for the market. He was free to dispose of his produce however he liked. Great Britain offered the best terms and he sent it here. The erosion set in not because he sold the grain—which he had to do in any event—but because he was using in semi-arid conditions cultivation methods developed for humid regions, and it was long before appropriate methods were worked out. The English farmer acted rightly in buying extra feeding stuffs while he had the chance—the Danish and Dutch farmers later on did the same to their great advantage; he is equally right in producing more of his feeding-stuffs at home now that he cannot buy from abroad.

A few errors have slipped into the text. The Rothamsted dates are wrong. The Broadbalk experiments were started in 1843, three years after the publication of Liebig's book, not ten years as the author states; Lawes's experiments on superphosphate had been started about 1838. Liebig did not demonstrate the effect of chemical nutrients on crop growth; he used the results obtained by others. One would like to have seen John Andrews, the farm labourer of Debenham, given the credit for discovering Chevallier barley: it was he that found it and grew it first; but the local parson, the Rev. John Chevallier, multiplied it for distribution so it was called after him. Apart from these minor defects the book is very interesting and well worth reading.

E. John Russell

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# CONTRIBUTIONS TO MATHEMATICAL STATISTICS

## Contributions to Mathematical Statistics

By Prof. R. A. Fisher. (Wiley Publications in Statistics.) Pp. xvii+658. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1950.) 60*s*. net.

THIS book consists of reproductions of a selection of forty-two of the author's more important scientific papers, together with a biography by Prof. P. C. Mahalanobis originally published in *Sankhya*. However, it differs in many ways from the ordinary volumes of 'collected works'. The papers have been selected by the author, and each paper has been prefaced by a short note indicating the circumstances which gave rise to it, and its relation to the common knowledge, or common misapprehensions, current at the time it was written. The papers are reproduced photographically, to the original size, with manuscript corrections and amendments. This produces a pleasing variety of text, and ensures that no new printing errors are introduced. The corrections that have been made are also apparent, a point which is of importance if the results have been used as a basis for subsequent work. Further, this method of reproduction has the very great advantage that it has enabled the book to be produced at a much lower cost, and with far less proof reading, than would otherwise have been possible. In this connexion, indeed, the generosity of the editors of the various scientific journals in permitting reproduction of their papers—only one journal, *Metron*, refused permission to republish—is to be warmly commended.

The selection of papers has been well done, though it is inevitable that there will be some disagreement as to what constitutes the perfect choice. One might, for example, have wished to see included the paper on "The Influence of Rainfall on the Yield of Wheat at Rothamsted" (*Phil. Trans. Roy. Soc.*, B, 213, 89; 1924), which contains a very elegant and original method of estimating the effect of rainfall at different times of the year, if necessary in preference to the earlier and less important paper on the variation in wheat yield from the same field ("Studies in Crop Variation. I. An Examination of the Yield of Dressed Grain from Broadbalk", *J. Agric. Sci.*, 11,

107; 1920). As an example of historical research, the paper on Mendel's work ("Has Mendel's Work been Rediscovered?", *Ann. Science*, **1** (2), 115; 1936), which is almost inaccessible in the original, is of lasting interest, while the relatively trivial paper on the half-drill strip method by Barbacki and Fisher ("A Test of the Supposed Precision of Systematic Arrangements", *Ann. Eugen.*, **7**, 189; 1936) seems scarcely worth reproduction without at least a reference to 'Student's' subsequent and not wholly unjustified criticism of it.

The collection will be of immense value to all mathematical statisticians, particularly those of the younger generation who have not had direct contact with the original articles when they appeared. As Fisher himself stresses in the preface, reference to original sources of mathematical research tends to be neglected—indeed, it is only by publications such as the present one that the ordinary student can hope to make any comprehensive study of the works of a single author. In the present instance, the study is of interest and importance, not only in revealing how the subject has developed, but also because many of the results obtained and methods described are still only available in the original papers.

The book is also a worthy monument to Fisher's achievement in mathematical statistics. Even to those who are closely acquainted with his work, it brings fresh realization of its immense scope and the genius that marks so much of it.

From the point of view of a student, there are, of course, defects in the use of collected papers by a single author in the study of a subject, in that only one side of a controversial issue is presented. In such a case what is really required is a collection of papers by different authors dealing with the same subject. The same is true when a subject is developed concurrently by several authors. Perhaps if the method of reproducing scientific papers adopted in the volume is found to be generally acceptable, collections of this kind dealing with specific subjects might be attempted.

F. YATES

## POLLEN ANALYSIS

### Text-Book of Modern Pollen Analysis

By Knut Fægri and Johs. Iversen. Pp. 168. (Copenhagen: Ejnar Munksgaard, 1950.) 16 Danish cr.

To quote from the preface of this little work: "Pollen analysis is still a very young science . . . and [it] has developed swiftly during the last 10 years". The aim of the authors, two well-known Scandinavian workers, has been to set forth, fairly exhaustively but simply, the technique in all its aspects and applications. This has been done in seventeen (unnumbered) chapters, which cover the subject thoroughly, from a short historical introduction to the latest suggested aid in pollen-grain identification—a perforated card key. The over-all result is an excellent book that cannot fail to be of very great help to everyone, mature worker or beginner, concerned with the science.

Some points, of course, in my opinion at any rate, invite criticism. In the chapter dealing with the pollen diagram, for example, it would have been more convenient for the reader if the example of a typical diagram (Pl. IX) had been inserted here instead of at the end of the book. As to the merits of different types of diagram, I have always held the opinion that the 'dissolved' (unhappy word) diagram as used by Dr. Godwin and his co-workers has much to recommend it for clarity and directness of appeal. It would have been helpful if an example of this type of diagram covering the (mainly peat) zones of the Post-Glacial Period had been inserted. The omission of any illustration of these zones is indeed strange, since pollen analysis, as we know it, after all was founded on peat; perhaps the answer to this riddle is to be found in the statement on p. 84 of the book, which reads: "For ordinary work one should never analyse peat if any sediment is available". This statement is altogether too sweeping. The 'ordinary' work of pollen analysis dealt, and still deals, with peat. Are we to understand, for example, that the fine work of Jessen on the Irish bogs, so recently published, is of little value? Surely not.

The pollen keys provided are 'artificial' keys, and result in many strange bed-fellows. They deal mainly with the pollen species likely to be found in deposits in north-west Europe. They will doubtless serve their purpose—but, as the authors are at pains to impress on their readers, a pollen herbarium is a *sine qua non* for the pollen analyst.

The book is pleasingly printed, and the authors acknowledge indebtedness to Miss Jean Allison and Mr. Philip Tallantire for linguistic advice and help in proof-reading. A number of awkward words and phrases have passed uncorrected, but these are not likely to mislead the serious reader. When a second edition is called for, however, as it well may be, the opportunity should be taken of correcting these solecisms—and making a good book better.

J. B. SIMPSON

## AMERICAN DECIDUOUS FORESTS

### Deciduous Forests of Eastern North America

By Prof. E. Lucy Braun. Pp. xiv+596. (Philadelphia and Toronto: The Blakiston Company, 1950.) 10 dollars.

The deciduous forests of eastern North America are treated in this book predominantly from the descriptive point of view, and Prof. E. Lucy Braun adopts as a basis the view that those forests which to-day appear to have been little modified by man can be regarded as indicative of the climax communities of the original forest cover.

The deciduous communities dealt with are considered by the author to comprise nine major forest regions based upon physiognomy and similarity of floristic composition. Historic factors are recognized as playing an important part. Thus, the mixed mesophytic forest region of the unglaciated Appalachian plateau is not only particularly the home of the chestnut, *Aesculus octandra*, and the white basswood, *Tilia heterophylla*, but is also perhaps significantly the habitat of the tulip tree, of ancient lineage. This region is by far the richest in species, with a number of kinds of trees constituting the canopy, usually more than thirteen even in a small sample area, together with a rich herbaceous vegetation some of the characteristic members of which have contributed to the beauty of gardens in England (for example, *Trillium grandiflorum*, *Erythronium americanum*, *Phlox divaricata* and *Tiarella cordifolia*). By contrast, the communities of the younger areas, where the forests are attributed to post-glacial immigration, exhibit only about half the number of arboreal species in the forest canopy, and the subordinate layers are floristically far less varied.

The mixed mesophytic forests occupy a relatively small area and are regarded as the lineal descendants of the Tertiary forests surviving in areas that have escaped glaciation, especially in the southern portion of the Appalachian plateau. The oak-hickory and oak-chestnut communities are held to represent local segregates from the mixed mesophytic type associated with more arid conditions. The communities occupying the largest areas are the hemlock-white pine northern hardwoods, covering a vast extent in the Great Lakes region, and the evergreen forests of the south-east, which are here included in the deciduous forest formation because their affinities are held to be closest with the other forest types dealt with.

For all the communities the author furnishes data from a number of sample areas respecting the woody constituents, and though reference is made from time to time to the herbaceous vegetation this is incidental rather than a feature of the main theme. The whole work is well illustrated by some eighty half-tone reproductions and nine maps, one of which is on a large scale, showing the limits of the forest regions as here defined.

The approach is essentially floristic rather than ecological, and habitat conditions are only briefly and generally treated; but within these limitations the work constitutes a valuable addition to the literature dealing with the arboreal vegetation of this area. E. J. Salisbury

## CIVIL ADMINISTRATION IN GREAT BRITAIN

### The Civil Service Today

By T. A. Critchley. With an Introduction by the Rt. Hon. Lord Beveridge. Pp. 150. (London: Victor Gollancz, Ltd., 1951.) 12*s*. 6*d*. net.

MR. T. A. CRITCHLEY in this book has set out to give a factual and objective account of the Civil Service in Great Britain and the way it works, as well as to indicate in what respects it differs from the pre-war Service. This was done for the administrative class ten years ago by H. E. Dale; but Mr. Critchley covers a wider field and, it must be admitted, his book is by no means easy reading. He succeeds in conveying a clear picture of the way in which the Civil Service has grown with the increasing demands on government for positive rather than negative functions, and of the way in which certain of its inherent weaknesses are linked to such measures for obtaining public control and ministerial responsibility as the parliamentary question. But something much more vivid than the few flashes he gives of four or five Civil servants at their daily work will be required to hold the interest of the many whom he is trying to convince as to the necessity for a Civil Service and the way its size is determined by the public demand for services; and to any thoughtful reader the picture he presents of the complexities of administration is as frightening as that which he gives of the extent to which the Civil Service now touches, and sometimes paralyses, the whole of civil life.

This is not nearly as profound a book as either Mr. H. E. Dale's or the more recent studies of Dr. E. N. Gledden or Mr. H. R. G. Greaves, though it could easily have had a wider appeal. On the whole, Mr. Critchley is too much on the defensive, and what he does not say is sometimes more significant than what he actually writes. A working Civil servant could after all have scarcely been expected to write the obvious rider as to the effect on the Civil Service, not to mention on Parliament and ministers, of overloading Parliamentary sessions with legislation, however admirable individual measures may be and no matter how much public support they receive. Disregard of administrative limitations may be as disastrous as disregard of known chemical or physical properties in technical development.

Even where Mr. Critchley might be expected to be less inhibited he is too reserved. More should have been said of the Whitley Council system in the Civil Service, on the real weakness of which he merely touches. Further, though he admits that Civil servants are not infallible, he is inclined to lay the blame for defects entirely outside the Service. Of local government he says little and that little is disparaging, betraying no hint that in the revivification of local government might be found the way to a solution of the problem of complexity at the centre. He questions, in fact, the value of devolution, and when he writes of the necessity for a real spirit of public service he is plausible rather than persuasive in arguing that by this means deficiencies in organization would be corrected.

Unquestionably more mutual understanding between the Civil servant and the public is required —and, also it might be added, a clearer appreciation of the limitations of the Civil Service on the part of Parliament and Cabinet. Mr. Critchley's book may do something to further that understanding, but the dominant impression it leaves on the mind of the reader is the necessity for some very clear thinking about not so much the organization and functions of the Civil Service but rather the whole structure and organization of government, and the imperative necessity for grappling with that problem of local government reform which all political parties seem determined to ignore or avoid.

There are three other points that will strike the man of science who reads this book. Mr. Critchley clearly believes that there is room for the wider diffusion of scientific methods throughout the Service and that such a step would have a tonic effect. Nevertheless, he is sceptical as to the effect on a democratic system if the man of science once comes to dominate, and he becomes confused when he refers to the man of science or other expert as an administrator. Much more dangerous to democratic institutes, however, is the tendency for parliamentary democracy under the conditions depicted by Mr. Critchley to pass into tyranny of the executive. It is clear from this book, that that danger is yet to be removed.

The third point that emerges from the figures given by Mr. Critchley and the general picture he draws is of the extent of the demand which present conditions make upon Great Britain for trained man-power. Can the nation afford to devote to non-productive tasks its highly trained men and women in the numbers required to execute the tasks now placed upon the Civil Service? Can the educational system of Great Britain supply the necessary administrative talent, even if we draw freely on all possible reserves of it from science and technology? These are but a few of the questions raised by a book that, purporting to be descriptive, is highly suggestive to any thoughtful reader and, for all its limitations, covers the ground at least as well as any other. R. Brightman

## Elements of Optical Mineralogy

An Introduction to Microscopic Petrography. By Prof. Alexander N. Winchell, with collaboration of Prof. Horace Winchell. Fourth edition. Part 2: Descriptions of Minerals, with Special Reference to their Optical and Microscopical Characters. Pp. xvi+551. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1951.) 100*s*. net.

THE fourth edition of Part 2 of A. N. and H. Winchell's "Elements of Optical Mineralogy" follows the third after an interval of eighteen years. During this period important developments in mineralogy have resulted from the intensified X-ray study of crystals, leading not only to increased knowledge of crystal structures, but also to a better understanding of variations in mineral composition, and to a revised classification.

As in previous editions, the book includes descriptions of all minerals the optical properties of which are sufficiently well known to permit diagnosis by means of a microscope. In bringing the work up to date, emphasis has been laid especially on the properties which serve this purpose; but details of the crystal structure of individual minerals as determined by X-rays are also given.

In the third edition, while the primary classification was chemical, the silicates were subdivided, so far as the knowledge of the time permitted, into groups on a structural basis. This system has been followed in the fourth edition; but the increased knowledge has permitted its extension to include within these groups all silicate minerals, with the proviso that the inclusion of certain minerals in particular groups is tentative. Opportunity has also been taken to bring into use the group names, tectosilicate, phyllosilicate, etc., proposed since the last edition.

This is a standard work, and it is regrettable that the increased cost of book production in the United States, and the current rate of exchange, necessitate a price that must put the book out of reach of many potential buyers.

## Industrial Solvents

By Ibert Mellan. Second edition. Pp. x+758. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1950.) 96*s*. net.

IN the eleven years which have elapsed between the publication of the first and second editions of this work, many new solvents have been discovered or developed for commercial use, and measurements of physical properties have multiplied. It is not surprising, therefore, to find that the size of the volume has increased by more than 50 per cent.

The first 200 pages deal with solution and general properties of solvents in a manner which may appear unorthodox to physical chemists, unless they realize that the subject-matter is concerned mainly with solvents and their uses in the paint and varnish industry. A bad fault occurring here and throughout the book is the presentation of data on solubility, viscosity and rates of evaporation without any mention of temperature. Many figures given in this part are repeated later, and it is suggested that a great improvement would result from a thorough revision and drastic curtailment.

The remainder of the book contains a vast amount of information of most diverse nature regarding the properties and uses of some four hundred liquids and their mixtures. Numerous commercial solvents are included and their composition indicated. Some of the data recorded appear to be of little value, while an item of real interest, the price of the solvents, has been omitted. Minor criticisms apart, however, there is no doubt that this volume, with its wealth of information collected from sources which are in many cases inaccessible to the average reader, must be regarded as indispensable to all those whose work involves the use of organic liquids. H. E. WATSON

## The Technology and Chemistry of Alkaloids

By Frank E. Hamerslag. Pp. viii+319. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1950.) 48*s*. 6*d*. net.

THIS book is primarily intended to assist those engaged in the manufacture of alkaloids. It is therefore principally, but far from exclusively, concerned with processes of isolation (or synthesis) and purification. Following a brief description of general procedures and technical equipment, the commercially practicable alkaloids are discussed in turn, either as individuals or as related groups, in eighteen chapters. Each chapter contains some discussion of the structural chemistry, the natural sources, the pharmacological properties and the means of identification of the appropriate alkaloids, in addition to a description of the manufacturing methods used. It is probably in this last respect that the main value of the book emerges, for the author is able to draw upon his personal experience in order to evaluate procedures, to give practical advice and to make specific recommendations. The detailed descriptions given of the methods of isolating individual alkaloids certainly merit the attention of all who have occasion to undertake these operations. The book is equipped with a comprehensive index and the text is liberally supplied with references to the original literature.

## The Thought of C. S. Peirce

By Prof. Thomas A. Goudge. Pp. xiv+360. (Toronto: University of Toronto Press; London: Oxford University Press, 1950.) 40*s*. net.

THE life of Charles Sanders Peirce (1839–1914) presents the world of scholarship with a problem at once profound and fascinating. Prof. Goudge, in writing this distinguished book, sets out to explain why this should be, and what can be learnt from it. Essentially, Peirce was an example of ambivalence; he was capable of an enviable analytic power at times (perhaps mostly) overwhelmingly naturalistic, at other times completely transcendental. If a conclusion is permissible regarding a life so fruitful and yet lived so dangerously, it is that his naturalism triumphed in his mind, his transcendentalism in his heart. This entailed a certain rigidity of partition between theory and practice, exemplified by the extremely abstract character of his thought when functioning as a philosopher or logician, alongside a thoroughly competent, almost mundane, affection for experimental chemistry, in which subject he graduated *summa cum laude*. When to all this is added more than a touch of the poet and the mystic (making him accord to æsthetics, for example, an exalted place in his hierarchy), it is clear with what a unique mind we are confronted.

Prof. Goudge shows a sure touch: he lets the restless intellect of Peirce shine through, without the interposition of a biographical screen. An excellent memoir is the result, full without being repetitious, understanding yet critical. F. I. G. RAWLINS

# A HUNDRED YEARS OF PLANT MORPHOLOGY*

By Dr. H. HAMSHAW THOMAS, F.R.S.

IN 1851 British botanists were still mainly occupied with the description and classification of plants, studies which were very similar to those which had been carried on since the days of William Turner in the sixteenth century. The work of men like Grew, Hales, Bradley and Knight, who realized the interest of plant physiology and plant biology, had exerted little influence on the main current of botanical thought; in fact, these men were not generally regarded as botanists. Botany was studied only in the field, the garden and the herbarium; botanical laboratories did not exist, and teachers like Henfrey and John Hutton Balfour (known to his students as "old woody fibre"), who attempted to develop anatomical study with the aid of the microscope, had met with little success.

At the time of the Exhibition of 1851, many of the outstanding botanists of the early nineteenth century were still living. Robert Brown, in his seventy-eighth year, was president of the Linnean Society; Sir William Hooker was director of the Royal Botanic Gardens, Kew; John Lindley was professor in University College, London; J. S. Henslow, Darwin's teacher, still held the chair of botany at Cambridge but was also rector of Hitchin and only resided in Cambridge during the Easter term; Sir Joseph Hooker had just returned home from his Himalayan journey, and Charles Darwin was quietly working at Downe on Cirripedes and brooding over the 'species question'. Modern botany was being actively developed in Germany by von Mohl, Nägeli, Hofmeister and others who had been stimulated by Schleiden; but it had very little influence in Britain. It is remarkable that there is no reference in the "Origin of Species", the letters of Charles Darwin or the published letters of Sir Joseph Hooker, to Hofmeister's "Comparative Researches on the Higher Cryptogams and Gymnosperms" which was published in 1851, and demonstrated the existence of an alternation of generations in these two groups—a powerful argument for the idea of evolution. This work was, however, translated into English and published by the Ray Society in 1862.

The outlook on plant structure in 1851 was that commonly held before the coming of the doctrine of evolution. Each species was believed to be the result of a separate act of creation; it had a form and structure which distinguished it from other plants. But among the great diversity of form it was possible by the exercise of the mind to recognize certain unifying principles. A mental picture of an ideal plant might be formed to serve as a standard with which all actual living forms could be compared. Goethe and the German Nature philosophers of the early nineteenth century formulated different concepts of the ideal plant, but Goethe's was the only one of lasting value. This was an imaginary organism consisting of a stem bearing a series of leaves showing various types of metamorphosis, or conceptual change, and having roots below the ground. Goethe's new science of morphology made considerable progress. We find Lindley expounding it in 1832 in his "Introduction to Botany". In 1857 Henfrey, in his "Elementary Course of Botany", writes: "the study of the metamorphosis of the organs of the flower is now advanced far enough to set all general questions at rest". Although his treatment of morphology and comparative anatomy is mainly descriptive, Henfrey defined this branch of botany as having the object of ascertaining what are the elements of plant organs, and of tracing out the laws under which they acquire the different forms presented in fully developed plants.

The publication of "The Origin of Species" in 1859 gave a new impetus and a change of direction to the comparative study of plant form. While Darwin himself did not claim that the parts of flowers had arisen in evolution from leaves of a uniform type, he mentioned that "almost everyone is familiar with the view that the floral parts are metamorphosed leaves". At first there seems to have been no change in botanical studies; but a great revolution in the outlook of botanists took place between 1870 and 1880.

The leaven of the concepts of evolution, the work of the great German plant scientists, the genius and energy of Prof. T. H. Huxley, the Education Bill of 1870 passed by Gladstone's Liberal Government, all combined to produce far-reaching results. Huxley had been teaching in South Kensington in buildings resulting from the 1851 Exhibition, and he undertook the organization of classes in biology to train teachers in science for the new public elementary schools. These classes included adequate practical work, an innovation in Britain at the time. Studies of a taxonomic kind were subordinated to the teaching of anatomy, physiology and the life-histories of plants. Thiselton-Dyer gave the first course in botany in 1873, assisted by Lawson of Oxford, Vines came from Cambridge as an assistant in 1875, and later Hillhouse, Daniel Morris and Bower took part in the teaching. Before long, teaching with laboratory work on the same pattern was begun in several British universities. Lawson began at Oxford, Vines, although not holding the chair, organized classes at Cambridge, Hillhouse went to Birmingham, and Bower to Glasgow. Dyer played a large part in the foundation of the Jodrell Laboratory at Kew, where much important work in plant morphology and physiology has been carried out.

The establishment of the Normal College of Science, which later became the Imperial College of Science and Technology, was a very important event in the history of botany in Britain. It produced a small band of enthusiastic teachers and investigators, two of them responsible for my own interest in botany, and it led to considerable activity in the investigation of plant form and structure.

At the outset, the exponents of the new botany concentrated on the objective study of all aspects of plant life. The great text-book by Sachs was translated into English and published in 1875. It contained little morphological theory; but plant structure was treated in some detail with frequent reference to the development of organs and their physiological implications. This book aided the new movement. But very soon the minds of biologists began to be influenced more and more by the ideas of

* Substance of a paper entitled "Changes in the Outlook on Plant Structure during the Past Hundred Years" read on August 9 before Section K (Botany) at the Edinburgh meeting of the British Association.

evolution, and the establishment of phyletic relationships became one of the chief endeavours of many British botanists.

Between the years 1880 and 1910 the study of plant structure was dominated by the belief that it held the key to the problems of phylogeny. Attention was mainly paid to the Pteridophyta and Gymnosperms, the possible connexion of which had been indicated by the work of Hofmeister. This climate of thought was intensified by the striking discoveries in Britain of fossil plants with well-preserved structure. These were especially due to W. C. Williamson, who was appointed professor of natural history in Owen's College, Manchester, on its foundation in 1851. Between 1868 and 1895 he described the structural details of many interesting and novel forms from the nodules of the coal measures of Lancashire and Yorkshire, and showed how some ancient pteridophytes were trees with secondary thickening. This and other contemporary work directed attention to the importance of this group in the vegetation of ancient times, while the structure of the stems called *Lyginopteris* and *Heterangium* suggested a connexion between the ferns and cycads.

All this historical evidence of evolution based on anatomical structure made a profound impression on the younger botanists of the time and many of them became active investigators. D. H. Scott, who was keeper of the Jodrell Laboratory, became associated with Williamson and afterwards continued to describe the structure of fossil plants; Kidston as an amateur began his detailed investigation of the Carboniferous plants of Scotland; Seward studied with Williamson at Manchester, and then specialized on the plants of the Mesozoic period; Oliver, working with Scott, established the characteristics of the Pteridosperms, and later added greatly to our knowledge of fossil gymnosperm seeds. At the same time, our knowledge of the living pteridophytes was being greatly extended, especially by Bower, who devoted his long life to the investigation of this group.

It would be difficult to exaggerate the importance of this period in the acquisition of factual knowledge, though the general trend of thought of the time is open to criticism from the philosophical aspect. For some twenty-five years it was assumed that Goethe's morphology could be forced into an evolutionary frame. As Dr. Agnes Arber so aptly writes, "by a feat of legerdemain, which seems to have passed almost unnoticed, the Ancestral Plant was substituted for the Archetypal Plant and those characters which had, with reason, been attributed to the mental conception of the archetype were, without further justification, assumed to have been proven for an actual historically existent ancestor". This point of view was encouraged among botanical students in Britain by the earlier translations of Strasburger's "Text-book of Botany". For a long time it proved a real stumbling block to the understanding of the fossil record, as well as creating an unbridgeable gulf between the Thallophyta and the Cormophyta.

The preoccupation of British botanists with the cryptogams and gymnosperms led to the realization of the value of anatomical characters in the study of plant morphology, a view that was regarded as heretical by the German botanists. It resulted, however, in considerable neglect of the flowering plants. Before 1920 almost the only extensive series of investigations in this group was the study of seedling structure under the leadership of Dr. Ethel Sargant. At first the aim of this work seems to have been mainly phylogenetic, but as it progressed Hill and De Fraine, and also Compton, were led to recognize the importance of physiological and ecological considerations.

The growth of the study of ecology, genetics and cytology towards the end of the first decade of this century diverted the attention of many young botanists from the pursuit of phyletic morphology. These subjects, as well as physiology and physiological anatomy, caused the problems of plant structure to appear in a new light. Bower's great book on "The Origin of a Land Flora" (1908) introduced biological considerations into morphological discussion and thus initiated a break with tradition; hitherto plant anatomy and morphology had been completely separated from physiological considerations.

From this time onwards there was in Britain a steady weakening of the view, expressed in Strasburger's textbook, that phylogeny is the only real basis of morphological study. This dictum was severely handled by Prof. W. H. Lang in his address to Section K of the British Association in 1915. He advocated a wider view of the significance of plant structure gained from the study of parallel developments, the methods of advance in different groups and in different generations of the life-cycle, the changes observable during development and the results of experimental treatment. Though this causal outlook is essentially different from the historical outlook, there is no opposition between causal and phyletic morphology. It has to be recognized that "there has been an evolution, not of mature plants, but of specific substances exhibiting development". Owing to the First World War, this admirable address probably received less attention than it deserved. A few years later Kidston and Lang published their full account of the plants of the Rhynie Chert, and opened up new lines of thought on plant evolution. They described very early plants which were completely different from the *Urform* of Goethe; and Lang's later work on the Silurian and early Devonian forms, together with that of Halle, Krausel and Weyland, showed that these forms were typical of the early cormophytes.

At the meeting of the British Association in Edinburgh in 1921, Dr. D. H. Scott as president discussed the phyletic implications of the recent discoveries in the Rhynie Chert, while Prof. Bower developed the causal side by a very interesting paper on size and form. Some of us who were present felt that, from these two aspects of morphology, real progress was being made; but the great problem was the bearing of this new knowledge on the morphological study of the flowering plants.

It seemed to me in 1932 that we should make no progress until we recognized clearly that Goethe's concept of metamorphosis had no evolutionary significance: for this reason I suggested that a fundamental distinction existed between the old morphology and the new. But this opinion has gained adherents very slowly. In the period between 1925 and 1939 Miss E. R. Saunders carried out a series of researches on the vascular structure of angiosperm flowers with the view of elucidating the evolution of carpels. While adding considerably to our factual knowledge, the value of her conclusions depends on the validity of her premises, and it seems doubtful if her basic suppositions were justified from a historical point of view. On the other hand, the work of Dr. Agnes Arber shows that most valuable results are forthcoming by strict adherence to the philosophical system of the old morphology. Many

people now find this approach to the study of form difficult to understand owing to our changed outlook on natural objects. They may have read papers like the admirable address on the interpretation of plant structure delivered to Section K of the British Association in 1939 by Prof. D. Thoday, and cannot envisage a system of thought from which biological and physiological considerations are excluded.

A survey of the changes in outlook since 1851 seems to show that form and structure can be viewed from three separate aspects: the old, abstract and purely intellectual approach; the causal and developmental point of view; the objective and historical study of plant evolution, which is, perhaps, still undeveloped as a logical system of thought. While these three branches of study will probably be best developed as separate disciplines, I believe that their results will eventually contribute to a synthesis of far-reaching importance.

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# GEOGRAPHY IN THE SERVICE OF MANKIND*

By E. O. GIFFARD, M.B.E.

A LAYMAN is not the right person to review the academic evolution of geography or to put forward detailed proposals for its further development as a scientific study: such matters must be left to those properly qualified to deal with them. A layman, however, may quite properly examine the record of the services of geography to the common people, and, indeed, may also be a proper person to urge that geographical knowledge shall be more frequently and widely applied in the conduct of both national and international affairs.

It is commonly said that 'pure' scientists are not concerned with or about the use made of the knowledge which they accumulate. Results, in their case, are said to be sufficient if it can be proved that something has been added to the store of human knowledge. This familiar argument is, of course, basically sound; but it appears to overlook the fact that, in the last analysis, a man of science is a specialist or expert employed in the service of his fellow-men. That is to say, he is, directly or indirectly, a servant of the public. Now the public is accustomed to assess the value of any study or activity by an analysis of its observed or deduced results. If the results appear to be good, then the study or activity in question continues to command respect and support and the specialists and experts concerned enjoy a high reputation. If, on the other hand, the results appear to be unsatisfactory or if, after a reasonable time, no results can be seen or deduced, then the value of the particular study or activity becomes suspect and the support accorded to its practitioners is liable to be diminished. For these reasons it is submitted that men of science and particularly geographers cannot afford to remain entirely disinterested in the use made of their knowledge and ought to do whatever they can to encourage its useful application.

As has been said, the public tends to evaluate a study or activity by its visible, demonstrable or deducible results. In this connexion the words 'visible and demonstrable' are particularly important. Remember the wisdom of those who insisted that justice must not only be done but must "manifestly be done". If public respect for scientific work is to be maintained at a high level and if financial support is to be forthcoming on an adequate scale, then the results of such work must be manifest. In this connexion the increasing dependence of our universities upon the public purse is not to be forgotten.

Results sufficient for the purpose need not, however, be directly produced by those who accumulate the required knowledge. It will serve well enough if they are usually produced by laymen who know how to use the knowledge or the techniques supplied by the professional experts, provided always that the experts receive adequate credit for the vital part they have played.

Compared with many other scientific workers or experts, the geographer is somewhat handicapped in the matter of producing visible or demonstrable results. The physicist, for example, lacks no publicity for the results of his labours, nor does the chemist or the engineer. The geographer, however, like the economist or the psychologist, deals largely in ideas which can rarely, if ever, be translated into anything which can be seen except upon paper. Perhaps he is a little better off than the economist and certainly he is better off than the psychologist, because the geographer at least has the solid earth as the subject of his study, whereas the psychologist is concerned with the invisible and intangible thought processes of the human brain. Nevertheless, the geographer creates few visible evidences of his work and it is not often possible for the layman to pause and point and say "that was done by a geographer".

Since geographers are not, in the ordinary sense of the words, either producers or administrators, since they do not till the soil, fish the seas, labour directly in industry, engage in trade or direct the energies of those who do these things, their contribution to the common effort and the common weal has to consist, on one hand, of learning and recording things about the earth as the home of man and, on the other, of teaching and advising. For visible results the layman has to be content with books and maps and things on paper: for other results he must rely on deduction rather than sight. In other words, he must look for abstract rather than concrete evidence. Naturally enough, he thinks of the geographer (when he thinks of him at all) as the informer, teacher or adviser, and he thinks he ought to be able to detect the influence of the geographer in many departments of human affairs. Nor is it unreasonable that he should do so. As practitioners of a subject which can claim no less than twenty-one academic chairs in Great Britain alone, as intellectuals equipped with special knowledge about the home of man, geographers ought surely to be found exerting a profound influence on the conduct of both national and international affairs. What are the facts?

Outside the universities and the schools, geographers are held to be of small account. In the departments of State, in local government, in industry and commerce and in the Fighting Services they are almost unknown. That surely must be very disappointing, if not humiliating, to professional geographers. Certainly it is a thought-provoking fact to laymen. Admittedly geographers have served on one Royal Commission (the Royal Commission on the Geographical Distribution of Industry) and may have served on others though not specifically as geographers. Some have served on the staff of the

* Substance of a paper read on August 10 before Section E (Geography) at the Edinburgh meeting of the British Association.

Ministry of Town and Country Planning (now known by another name, but, like the rose, retaining the same odour), and a few have been appointed to similar posts in local government. A few may be serving in administrative posts in the Dominions and Colonies, and it is possible that one or two are to be found as advisers in industry and commerce. Some there are, of course, serving with distinction in the Fighting Services, but few of these serve as geographers. In truth, the number of qualified geographers employed as such in any sphere of administration or in any public service may fairly be described as negligible. Only as teachers in the universities and schools may the qualified geographer be found in fair numbers, and sometimes, even in such places, he still has difficulty in maintaining his status and dignity as an important specialist.

It is clear, therefore, that, if geographical influence has been brought to bear on problems of the day, it has been largely exerted by laymen. We know, of course, that laymen do apply geographical knowledge daily in matters great and small; but there must be very few laymen in positions of authority whose knowledge and appreciation of geographical principles are equal to the requirement. Unfortunately, also, laymen making use of geographical knowledge are often not very sure what sort of knowledge it is that they are using, and very few of them ever pay tribute to the people from whom they obtained it. Thus the professional geographer rarely gets any credit and, unless he is a school teacher, he remains in the background—a vague, shadowy figure whose function remains largely a mystery to the layman.

Are things any better elsewhere? Let us see what those who ought to know say about the state of affairs in France. M. Georges Chabot, professor of geography in the Sorbonne, agrees with M. Louis François, inspector-general of public education in France, that "The Public is largely ignorant of Geography and the Press is in the same state": and that in France, which has produced some of the greatest geographers of all time. In Germany, where geography was once held in the highest esteem, the subject is making progress towards revival but has had to pay heavily for having allowed itself prior to 1939 to become the tool of political gangsters. In the United States geography is alive, and geographers are more vocal than in Britain; but convincing evidence of intelligent application is lacking or difficult to find. As for American politicians, they pay lip service to geography but their actions sometimes justify doubts as to whether they fully understand what they praise. In other parts of the world the situation seems to be the same or not so good. The truth is that, although geography has marched forward in the universities and the schools of a great many countries, it remains barely noticed by statesmen and administrators and is largely ignored by the average, adult citizen.

In the British Commonwealth great problems arise almost weekly which demand the assistance of the best brains and the wisest heads; but though quite a number of these problems lie well within the legitimate field of the professional geographer, he is seldom consulted. What, perhaps, is more deplorable is that geographers themselves do not seem to exert themselves to make their influence felt. Far-reaching political and economic proposals are widely debated in Britain in connexion with which the qualified geographer could render signal services by contributing his knowledge and stating his convictions, and yet never, or scarcely ever, is his voice raised loud enough or in time to affect the issue. Charged with indifference or sloth in these matters, some geographers have said that it is not consistent with their position or their dignity to join in political or other public controversies. It is here submitted that such an attitude is wrong. To remain aloof, withholding vital information or advice merely because no one has thought of asking for it, is equivalent to issuing an invitation to be ignored. Unfortunately, there are many who, for one reason or another or for no reason at all, fail to seize the opportunities for service which offer themselves. We may find in that fact one of the reasons why geography lacks its fair measure of public esteem and support and why so few geographers are to be found in positions of influence outside the academic field.

It is one hundred years since Section E of the British Association was established. By now geographers should be able to point with proper pride to the achievements of their kind in administration and public affairs. There should be trained geographers employed, at least as advisers, wherever geographical knowledge is essential to wise decisions and intelligent action. The simple fact that geographers are so rarely to be found occupying such posts is evidence enough that geography has not yet become the force which it ought to be. Geographers have knowledge which contains the seeds of a great power for good. Wisely disseminated and applied, that knowledge might yet do much for mankind and for the peace of the world. It is time that that knowledge became more widely known and used, and it is more than time that geographers took action to make it so.

That the study of geography has done good and has accomplished much would not and could not be denied by any intelligent person who cared to give the matter careful thought. The great wealth of information which has been so patiently collected, analysed and recorded in the forms of books, papers and maps is irrefutable evidence of the skill and industry of practitioners of the subject. In the practical sphere the record of exploration and of research work in the field is a record of which geographers may justly be proud. In the schools of Great Britain the teaching of the subject has been revolutionized, and slowly but surely it has gained status and respect despite many handicaps and a good deal of unreasoning opposition. In the universities, as we all know, the subject has advanced beyond the most sanguine hopes of those who laboured fifty or more years ago to obtain for it a bare foothold. Yet, despite these achievements we cannot pretend that things are satisfactory. The authors of the Unesco pamphlet entitled "Towards World Understanding" have felt obliged to write ". . . in spite of the progress of geography in methods of research and dissemination, the efforts of geography teachers produce disappointing results". Again, in the same pamphlet they go on to say, ". . . actually less is known of geography to-day than formerly". We may question the accuracy of these statements; but it is impossible to deny that the mere fact that a number of distinguished geographers and teachers can agree to make them is alarming.

Another thing which is disquieting is that, despite the brilliance of many of the teachers and the interesting manner in which the subject is presented in so many schools, pupils are not generally enthusiastic about geography. It is safe to say that, in most

cases, geography is the subject which promising pupils want to drop when they are approaching the period in school-life when something has to be given up to allow for more intensive study of other subjects. In this readiness to drop geography towards the culmination of the school course and in the desire to avoid taking it in the examinations, the more brilliant pupils are all too often encouraged by head teachers, who seem prone to share the pupils' lack of interest in the subject. What can be the explanation of this? It is submitted that the explanation is the same as that already suggested as being the cause of apathy in the adult citizen, namely, lack of evidence that geography is something applicable to life. Children can see daily evidence of the application of physics, chemistry, mathematics, biology and engineering, but they rarely see or hear anything in the world outside school which would lead them to believe that geography is something that really matters. As we have already said, geographers create few if any visible monuments, are rarely heard, seldom reported and are not often seen at work in a way which renders them recognizable to laymen as geographers. As more than one senior pupil has said to me: "You never hear of anybody *doing* anything with geography: it's just a school subject". Those pupils had the wrong idea, of course, but can we blame them? Geographers rarely speak in Parliament or in the local council chamber. Comparatively few of them give lectures to the general public on the problems of the day: very few are heard on the wireless, and then, as a rule, only on the Third Programme. They are practically never alluded to in films, even incidentally, and they almost certainly occupy less space in the newspapers than other scientific workers. Thus there is little indeed to indicate either to the adult or the adolescent citizen that geographers exert any influence or do any notable service.

To no one would this sorry state of affairs give greater distress than to that great geographer and public servant, Sir Halford Mackinder, were he alive to-day. Mackinder, perhaps more than any other great geographer, believed in the application of geography to world affairs; that is to say, he believed in it being not only studied but also used for helping to solve some of the problems of mankind. He saw it as a power for good and believed that, properly applied, it could help the statesmen of the nations to agree on wise and practical territorial arrangements which would remove some of the more potent causes of war. He saw it as at once both a science and a philosophy and also as a technique which could be applied to a great variety of human problems—local, national and international. Had geography been so used it could not now appear to so many ordinary people as the purposeless and almost barren study which to too many of them it seems to be to-day.

Fortunately, signs are not altogether wanting that some geographers of standing have at long last sensed the need to explain their purpose and demonstrate their techniques to educated laymen. Some also seem to be awakening to a more proper appreciation of their responsibilities as workers in the social and political fields. Even since the first draft of this paper was written there have been some significant developments in this direction, and they are to be welcomed. Unesco has done a service to geography by indicating its possible application to the problems of world understanding and by exposing the failure, up to the present, of geographers generally to grasp their opportunities in this connexion. Finally, mention must be made of the Land Utilization Survey which, whatever criticisms may be justly levelled against it, represents a gallant and largely successful attempt to apply a geographical technique to a social purpose.

In regard to the application of geography, let us contemplate only a few of the things geographers could do now. They might, for example, turn their minds to some of the pressing territorial problems which threaten the peace of the world instead of concentrating their studies upon areas or regions which, however interesting academically or useful as subject for an exercise, are not in the minds of the public and are not storm centres of the day. They might usefully express views on the great problem of the production and distribution of raw materials. They might put forward a constructive scheme, based on sound geographical principles, for the amendment of the areas or regions of local government in Britain. They might give us soil maps. Other things in which we are all interested are (to take only a few instances at random): better plans than exist at present for the re-distribution of the urban population; the better development of Commonwealth resources; the future of Africa and particularly of parts of that continent; and the great problems of world over-population. Indeed, there are a score or more of golden opportunities for the geographer to make his mark and prove his worth in contemporary affairs. Cannot some of them be taken? Perhaps the answer will be given that they have been taken. If so, then the work which has been done must be hiding in the pages of some professional journal or in the archives of some university or learned society and has not yet been brought to the notice of the world at large.

As to the employment of geographers in the departments of State and in the public services, we cannot hope for much improvement in the present position until geographers have succeeded in establishing themselves more securely in public esteem; and they can only hope to do this by making themselves useful and by letting the world see or hear about their good works. In this connexion it would be helpful both to geographers and laymen if the great daily newspapers would appoint qualified geographers as special correspondents. If that were done, the views of geographers would be more often quoted and the value of their special knowledge would be more widely appreciated.

These latter years have witnessed the development of a number of geographical sects—each sect preoccupied with one particular aspect of geography and each sect waging a kind of cold war against the others. Indeed, not infrequently of late, it has seemed that sectarian interests have been allowed to rise superior to the good of geography as a whole. That there should be some workers in the field who are more interested in one part than in the other parts is natural, necessary and good; but it is not good for such persons to be allowed to proclaim that the part in which they happen to be most interested is the part which matters most. Nor is it good that such persons should be allowed to pour contempt on the special work of others. The part cannot be greater than the whole, and when anything is compounded of parts, as geography is compounded, every part is essential, for, missing a single part, the whole cannot exist.

It is submitted that the professors, who are the academic leaders, would be wise to bring all their influence to bear against those who, either with intent or inadvertently, would break up the synthesis into its component parts and, this done, would seek to proclaim themselves the high priests of their particularly favoured mysteries. That way lies disintegration and disaster. Let there be controversy by all means; but let it be conducted in an atmosphere of mutual respect and always with the main object of furthering the study of geography as a whole, rather than of any one part of it. Let the elder statesmen of geography exhibit a unity of fundamental ideas and a determination to maintain an essential discipline.

In 1931 Mackinder forecast that, towards the middle of the twentieth century, geographers would have their golden opportunity. He said: ". . . then will be the opportunity of the geographer-statesman, for geography must underlie the strategy of peace if you would not have it subserve the strategy of war". Unheeded by too many, that hour has struck! The geographer, that is to say the person trained to think geographically, is better equipped than most other people to see through the fog of political propaganda and the mists of emotional nationalism and to discern the real, underlying causes of discontent and disturbance. Could the geographer but bring his influence fully to bear in the counsel of the nations, could he but gain for his knowledge and skill the respect which both so richly deserve, there would be at his command a power which might do much to ensure fair and just territorial settlements, bring about a more equitable distribution of the world's natural wealth, promote better understanding between peoples and remove some of the more potent causes of wars. That, indeed, would be service to mankind. That power, however, will not be granted to geographers until they have given more abundant proof of their qualities and capabilities and of the usefulness of their special knowledge.

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# VARIATIONS IN BROOD-STRENGTH IN THE NORTH SEA HADDOCK, IN THE LIGHT OF RELEVANT WIND CONDITIONS

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MANY years of research into the biology of the haddock (*Gadus æglefinus*) in the North Sea have shown that one of the major factors contributing to the short-term fluctuations in the fortunes of the commercial fishery for this species is the varying numbers of recruits entering the fishable stock from year to year. The importance of this phenomenon was firmly established during the early inter-war years by Thompson[1] (then of the Marine Laboratory, Aberdeen), who, from the results of extensive research vessel trawling surveys in the North Sea, was able to relate the fluctuating yields from the fishery to this cause. These surveys, which were afterwards extended by Raitt and later by Parrish (of the same Laboratory), gave estimates of the distribution and relative density of each brood of haddock throughout its demersal life and thus gave measures of the relative stock strengths from year to year, and provided a means for forecasting, a year in advance, the relative success of the commercial fishery. The magnitude of the fluctuations in brood-strength over the period 1920–49, exclusive of the war years 1939–44, are illustrated in Fig. 1. This gives the mean annual catch per hour of fishing relative to that in 1923, rated as 10, taken with the trawl of the research ... for each successive brood in its second year of life, by which time its members have become demersal.

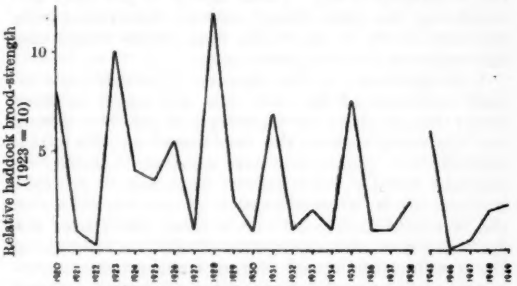


Fig. 1. Fluctuations in haddock brood-strengths in the North Sea, 1920–49

In an attempt to assess the factors causing these fluctuations, the first step which had to be taken was to determine that critical stage in the haddock's development, up to the end of its second year of life, during which the observed fluctuations in abundance may be experienced. The possibilities may be summarized as follows: (1) variations in egg production from year to year; (2) annual changes in the survival-rates of eggs, larvæ and young fish during the pelagic phase; (3) annual changes in survival-rate after the demersal stage has been reached.

In a paper read before the Challenger Society in 1949 (now in preparation for publication in detail) an analysis was made of the large volume of data of the distribution and density of each brood in its first and second years of life, and of the egg production potential of the spawning shoals from year to year during the period 1920 to 1949. This has yielded the following results: (1) variations in abundance of successive haddock broods cannot be properly attributed to corresponding variations in egg production potential of the spawning shoals; (2) no large-scale differential mortality can be traced after the haddock become demersal and before they reach trawlable size.

These results lead to the important conclusion that the factors determining the level of recruitment are operative during the pelagic phase of the haddock's life-history. These factors must, therefore, be sought among the complexity of physical, chemical and biological features of the pelagic environment in which the eggs and larvæ develop, and for most of which no serial observations over a wide enough area are available.

Of these features, one which has received much attention in the marine field and has been considered to be critical for the survival of many species of

organisms is the current system of the upper-water layers, within which the spawning products develop and are distributed by its changing speed and direction into areas favourable or unfavourable for subsequent development. The possible importance of such changes to the survival of haddock in the North Sea is apparent from a knowledge of the disposition of the spawning area in relation to the surrounding water masses. Spawning takes place in the northern North Sea basin, chiefly within the boundaries of the large elliptical eddy system described by Tait[2], which to the north and east is bounded by deep-water masses, the movements of which are northerly or north-easterly in direction. Any spawning products driven into these waters will, therefore, be swept away from the North Sea along the Norwegian coast. Those driven to the west and south, on the other hand, will be distributed over the main body of the North Sea, which constitutes the main haddock nursery area.

Unfortunately, in the absence of precise year-to-year measures of the direction and speed of mass water transport in the northern North Sea during the spawning season, the importance of this phenomenon to haddock-brood survival cannot be assessed directly. An indirect approach is possible, however, from a consideration of the variations in the direction and speed of the local winds over the spawning area, the importance of which in influencing the direction and speed of local surface water movements has been demonstrated by Carruthers[3] and Carruthers, Lawford and Veley in a series of papers recently published. Striking preliminary results were obtained in 1938 by Carruthers[4] from an analysis of variations in haddock-brood strength and variations in the wind component from the south-east quadrant as deduced from barometric pressure data.

A more complete analysis of this relationship was made possible following the preparation by Dr. G. Dietrich, of the German Hydrographic Institute (Hamburg), of monthly wind resultants of a high degree of accuracy for the northern North Sea, covering the years 1900–49. Relative haddock brood-strengths for the years 1920–49 (exclusive of the war years 1939–44) have been used and, for each year, the wind values for the four months February to May have been taken. An account of the analysis was prepared by us and read before the International Council for the Exploration of the Sea in October 1950; on that occasion a full exposé of the underlying ideas was given, and these have now been presented in a paper, "An Attitude on Fishery Hydrography", due to appear in the United States shortly[5].

An initial analysis of these data showed that, in general, high haddock values occurred during years when southerly and easterly wind components were large, and northerly and westerly small, whereas low haddock values were accompanied by reversed conditions. In view of these results, a wind function, $H = \sqrt{S^2 + E^2} \sim \sqrt{N^2 + W^2}$ (where $S$, $E$, $N$, $W$, are the four wind components), was developed by Veley and was used in the subsequent analysis. The values of $H$, derived in this way, are plotted against the relative haddock values in Fig. 2. The value for $\sqrt{S_2 + E^2} > \sqrt{N^2 + W^2}$ and vice versa are plotted separately.

The conclusions to be drawn from these results are as follows:

(1) When the $S\,E$ term is large compared with the $N\,W$ term, dispersal of the spawning products is in a north-westerly direction. This appears to be the most favourable to brood survival.

(2) When the $S\,E$ term is small compared with the $N\,W$ term, dispersal is in a south-easterly direction. This is also favourable to brood survival, but to a lesser extent.

(3) A small value for $H$ might arise either from a north-easterly or a south-westerly dispersal, or from no dispersal. Such a small value for $H$ has always been found to be unfavourable to haddock survival so far, but, over the period of years investigated, a small value of $H$ proved always to be due to south-westerly winds causing north-easterly dispersal.

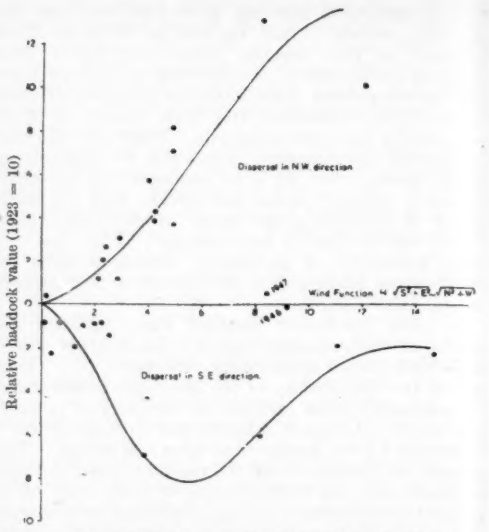


Fig. 2. Relationship between relative haddock value and wind function

The importance of these results is evident when they are considered in relation to the movements of the water masses surrounding the spawning area as outlined above. Thus, distribution in a north-westerly direction will dispose the spawning products within the eddy or, if out of it, into the southerly running stream entering the north-western North Sea from the Atlantic; this will distribute them over the main body of the North Sea, which is the main nursery area for adolescent haddock. Similarly, dispersal in a south-easterly direction is favourable unless the spawning products are driven beyond the boundaries of the eddy, when they will enter the north-going stream along the Norwegian coast and will be lost to the North Sea. Calculation shows that this is likely to take place for values of $H$ greater than 6, which is the value at which the maximum occurs in the $S\,E$ dispersal curve in Fig. 2. Dispersal to the north-east will also drive the spawning products into the northerly-going current which runs along the eastern and northern boundaries of the eddy.

These results can, therefore, be explained in terms of the wind-induced movements of the water masses in the spawning area, and of the prevailing current systems of the surrounding waters. In the absence of precise data of the distribution of the spawning products, the validity of this interpretation has yet to be substantiated. The close relationship of the success of haddock-brood survival to the prevailing local winds during the spawning and post-spawning

periods is, however, clearly demonstrated for all but two out of the twenty-four years investigated. In the years 1946 and 1947, some over-riding factor or factors must have dominated the haddock development. This may have been, for example, temperature, and it is interesting that the 1947 spawning followed one of the coldest winters in recent years. Nevertheless, it is considered that a knowledge of the wind conditions over the spawning area may lead to accurate predictions of future haddock-brood strengths, at least a year in advance of data obtainable at present, either with a research vessel or from commercial statistics, that is, two years in advance of the entry of these fish into the commercial fishing.

A fuller account of this work will be published elsewhere (Scientific Investigations, Fisheries Division, Scottish Home Department).

[1] Thompson, H., *Rapp. et Proc.-Verb. Cons. Perm. Int. Exp. Mer*, **68**, (1930).
[2] Tait, J. B., Fish Scot. Sci. Invest., No. 1 (1937).
[3] Carruthers, J. N., Min. of Agric. and Fish. Fish Invest., Ser. II, **14**, No. 4 (1935).
[4] Carruthers, J. N., *Rapp. et Proc.-Verb. Cons. Perm. Int. Exp. Mer*, **107** (1938).
[5] Carruthers, J. N., *J. Mar. Res.*, **10**, No. 1 (1951).

# NEWS and VIEWS

## Chemistry at Queen Mary College, London: Prof. J. R. Partington, M.B.E.

PROF. J. R. PARTINGTON retires this summer from the chair of chemistry at Queen Mary College, University of London, which he has held since 1919, and has been appointed emeritus professor in the University. After graduating at Manchester, where he won the highest academic honours, he worked first with Dixon, and then with Nernst at Berlin, and so founded his lifelong interest in inorganic chemistry and in the physical methods for the study of chemical problems then being newly developed. During the First World War he served in the Army, and later did research work in applied chemistry for the Inventions Department of the Ministry of Munitions, before succeeding Prof. Hewitt at Queen Mary College. To his colleagues in London his outstanding characteristics are, perhaps, first his wide and scholarly knowledge of chemistry, secondly the integrity, precision and good sense with which he has always discharged his University duties, whether as examiner or as member or chairman of University boards and committees, and thirdly his lively and ever-growing interest in the teaching and exposition of chemistry.

Prof. Partington is, of course, well known for his researches on the reactions and constitution of many inorganic compounds, on the properties of gases, on electrochemical problems, on dipole moments of organic liquids, on solubility and various other subjects; many of them are models of critical thought combined with great experimental skill. His greatest contribution to the development and spread of chemical knowledge probably lies, however, in the books he has written and is writing. Prof. Partington's interest in the history and literature of science, based largely on his own extensive library, is apparent in all his works, and as an authority in this field he is president of the British History of Science Society and a member of the committee of the London Library. Since he intends to continue writing, chemists generally will be happy to know that they are likely for many years to come to have the benefit of his encyclopædic knowledge presented to them with the meticulous clarity and precision they have learned to expect from him.

## Dr. M. J. S. Dewar

DR. M. J. S. DEWAR, who succeeds Prof. Partington at Queen Mary College, was educated at Winchester and Balliol College, Oxford. For the past six years he has been working at Messrs. Courtaulds Research Laboratories at Maidenhead. Dr. Dewar has become prominent mainly for his theoretical work in applying wave mechanics to problems of organic chemistry, though in recent years he has also made interesting kinetic studies of polymerization and oxidation processes. His book on "The Electronic Theory of Organic Chemistry" has been one of the most stimulating and controversial contributions to organic chemistry of recent years. In it he has elaborated applications of the wave concept of the probable behaviour of the reactive '$\pi$-electrons' of unsaturated and aromatic systems in the interpretation of the mechanisms of organic reactions, and has shown how these theories can be extended in consideration of the transition states of reacting systems. Undoubtedly the most notable advance in organic chemistry which has resulted from these concepts is the recognition of the aromatic character of the seven-membered ring in tropolone, and of its existence in several natural products, as, for example, colchicine. As yet, few accurate experimental results are available for testing the more quantitative implications of Dr. Dewar's many computations, but it now appears that the modern analytical techniques of isotope analysis and infra-red spectroscopy should facilitate the rapid growth of the more quantitative aspects of organic chemistry to which wave mechanics will provide an essential theoretical background.

## Industrial Research in East Africa: Mr. H. B. Stent

MR. H. B. STENT has been appointed director of industrial research in East Africa. This step results from discussion between the East Africa High Commission and the Standing Committee on Finance of the Central Legislative Assembly on ways of speeding up the establishment of an industrial and research organization to provide adequate scientific background for the existing industries in East Africa and to encourage new industrial development. It had first been envisaged that an organization should be established with functions similar to those carried out by the Department of Scientific and Industrial Research in Great Britain. Detailed consideration indicated, however, that it would be more effective to set up an organization mainly confined to matters having a high priority in relation to development in East Africa. Mr. Stent has acted as chairman of the East African Research Board since 1946.

It has also been agreed by the Governments of the three High Commission territories that the present Industrial Research Board should be reconstituted as a Scientific and Advisory Committee under the chairmanship of the director. It will consist of

scientific and technical representatives of the three territories, together with a panel (also nominated by them) of persons specially qualified in particular branches of science and technical matters. This new Committee will be advisory to a new and smaller Board comprising representatives of the High Commission and the three territories, which will be under the chairmanship of the Administrator to the High Commission. The new Board's duties will be, principally, the maintenance of full liaison between the organization and the Governments, determination, with the consent and backing of Governments, of priorities, etc., affecting research, and the review of progress in research. It is expected that the new Board will be constituted shortly. The laboratories operating under the old Industrial Research Board have, during the past few years, carried out research into a large number of matters concerning industrial development in East Africa, in addition to analytical work. These matters include investigations on phosphatic fertilizer production; refractories and ceramics, including bricks and roofing tiles and drain pipes as well as domestic pottery; cement production; charcoal production with by-products; soda production from Lake Nakuru; and the extraction and treatment of fresh pyrethrum flowers.

## Statistics at the Australian National University, Canberra: Prof. P. A. P. Moran

A CHAIR of statistics has recently been created in the Research School of Social Sciences in the Australian National University, Canberra, and Dr. P. A. P. Moran has been elected as its first occupant. Dr. Moran, who is thirty-four, was born in Sydney and educated at St. Stanislaus' College, Bathurst, at the University of Sydney, and at St. John's College, Cambridge. During the Second World War, he served as an experimental officer in the Ministry of Supply and (later) as Australian scientific liaison officer for physics and operational research. Since the War, he has been lecturer in mathematics at Trinity College, Oxford, University lecturer in mathematics, and a senior member of the Oxford Institute of Statistics. He is a Fellow of the Royal Statistical Society and has played a prominent part in the post-war development of the Society's Research Section, and in the creation of a school of mathematical statistics in Oxford. Apart from earlier work on the pure mathematics of measure, Dr. Moran is chiefly known for his papers on the statistical theory of ranking, and on the theory of stationary time-series. He has collaborated with Prof. A. S. C. Ross on the dating of manuscripts by the statistical analysis of philological data, and with the Oxford Bureau of Animal Population on some problems of population dynamics. At the present he is interested in the problems of estimation arising out of the theory of stochastic processes.

## American Scientific Mission to West Germany

AN American scientific mission, headed by Dr. Harold Vagtborg, president of the Southwest Research Institute, San Antonio, Texas, is undertaking a survey of West Germany's scientific research resources under the sponsorship of the Economic Co-operation Administration. In addition to staff members from the Southwest Research Institute, the group, which is spending a month in Europe with headquarters at Bonn and Paris, includes research officers from the Armour Research Foundation of Chicago, the Battelle Memorial Institute of Columbus, and the Stanford Research Institute of Palo Alto. The primary object is to determine whether a need exists for the establishment of applied research institutes to serve small and medium-sized manufacturers and processors in West Germany in the interest of national security and, if it does, how best to set up such laboratories. The West German Government itself asked for this survey to be made. The same group has already given assistance in establishing similar industrial research laboratories in Norway, and in the development of a programme leading to the inauguration of a scientific institute in Brazil. It is hoped to carry out similar surveys in other countries of Western Europe.

## Advisory Committee on Metals Economy

THE Minister of Supply, in conjunction with the Lord Privy Seal as Minister of Materials, has appointed an Advisory Committee on Metals Economy to help him to ensure the most economical use of metals in the engineering industry and in the defence programme. The terms of reference of the committee are: "To bring under review in consultation with the various Government and industrial authorities concerned ways of economizing in the use of scarce metals in the design, specification, and the manufacturing process of metal goods for both rearmament and civil purposes, and to advise the Government how it can best assist in promoting such developments".

The committee will be under the chairmanship of Mr. D. A. Oliver, director of research at the Birmingham Small Arms Co., Ltd. The other members are drawn from industry and Government departments. The industrial members are: Dr. G. L. Bailey, British Non-Ferrous Metals Research Association; Mr. H. A. R. Binney, British Standards Institution; Mr. H. H. Burton, English Steel Corporation, Ltd.; Mr. W. C. F. Hessenberg, British Iron and Steel Research Association; Mr. E. W. Grinham, Standard Motor Company, Ltd.; Dr. Ivor Jenkins, General Electric Co., Ltd.; Dr. L. B. Pfeil, Mond Nickel Co., Ltd.; and Dr. C. J. Smithells, British Aluminium Co., Ltd. The secretary is Mr. K. M. McLeod, of the Engineering Industries Division of the Ministry of Supply.

## Student Health Services

THE sixteenth issue of *Communication*, the organ of the International Association of University Professors and Lecturers, contains the Association's report upon the provision made in the universities of many countries for the health of their students. Some time ago a questionnaire was addressed to university authorities in all countries, thirty-six of which replied. In these thirty-six countries the great majority of universities accept the principle that they have some responsibility for the health of their students as well as for the way in which services should be organized and paid for. From the replies received it is clear that in the health examinations of the ordinary student at entrance to the university and on subsequent occasions very real importance is attached to the X-ray examination of the lungs. There is a general consensus of opinion that there should not be any exacting psychological examination of the ordinary student's mental health, although in some cases the help of a psychiatrist has been sought. The Association recommends that, in assessing the menta

health of a student, the indirect approach is the most suitable, although a counselling psychological service is advised for the universities of countries which have suffered most from the War. The report also contains sections setting out the Association's views on the provision of some form of health instruction, the inspection of the student's environment, the treatment of minor ailments of the sick student and the treatment of students who are seriously ill.

## Pests of Ornamental Plants

THE late G. Fox Wilson performed a great service to horticulture in his studies of insect and other pests which attack flowers and shrubs, and a compendium of these studies was first published by the Ministry of Agriculture and Fisheries in 1937. This has long been out of print, so that a second edition, enlarged and modernized, is very welcome (Bulletin No. 97, Pests of Flowers and Shrubs; 105 pp.+117 pl.; London: H.M. Stationery Office, 1950; 4*s.* 6*d.* net). A short general introduction is followed by fairly detailed consideration of measures of control. The more ubiquitous pests such as slugs, millepedes, aphids, wireworms and leatherjackets are described in a general section, and thereafter localized pests on lawns, borders, bulbs and corms, rock gardens and glasshouses receive consideration. Such a horticultural arrangement necessitates a more adequate index than is provided, for it is not always easy to make rapid reference to a particular pest. This slight criticism must not, however, be allowed to detract from the value of the bulletin, which is a sound book of reference, thoroughly informative and very well illustrated. It should appeal to the gardener and equally to the advisory officer. One useful feature is that the results of future work with modern sprays, like HETP and TEPP, or modern soil treatments like benzene hexachloride, will be readily applicable to the text, for control measures have been considered as principles rather than mere specific remedies.

## St. Andrews Mathematical Colloquium, 1951

MANY mathematicians will remember with pleasure the colloquia held at the University of St. Andrews under the sponsorship of the Edinburgh Mathematical Society in 1926, 1930, 1934 and 1938. It was intended to hold such meetings every four years, but the War and the difficult post-war conditions made this impossible until now. The fifth St. Andrews Colloquium took place during July 18–28, and proved even more successful than its predecessors. There were 110 people present at University Hall, St. Andrews, including overseas representatives from Australia, Belgium, Canada, Egypt, Eire, Holland, India, Switzerland and the United States. The inaugural address was given by Prof. H. W. Turnbull, who gave an account of the fascinating historical researches arising from the preparation for publication by the Royal Society of the letters of Isaac Newton. There were five sets of formal lectures: (1) Prof. H. S. M. Coxeter (Toronto) on kaleidoscopes and quadratic forms; (2) Prof. A. Erdélyi (Pasadena, California) on the analytic theory of systems of partial differential equations; (3) Mr. A. E. Ingham (Cambridge) on the analytic theory of numbers; (4) Prof. J. L. Synge (Dublin) on the geometry of function-space and its applications to mathematical physics; (5) Prof. G. Temple (London) on mathematical problems of supersonic aerodynamics. In addition, single lectures were given by Prof. Sophie Piccard (Neuchâtel) on the theory of groups and by Prof. L. E. J. Brouwer (Amsterdam) on the influence of mathematics on logic. At the concluding meeting, Prof. Temple expressed the thanks of all present to those responsible for the successful organization of the colloquium, in particular to Dr. D. E. Rutherford (St. Andrews). It is hoped that the sixth St. Andrews Colloquium will be held during 1955.

## Society of Dairy Technology

THE Council of the Society of Dairy Technology has established a medal, to be known as the Society of Dairy Technology Gold Medal, which will be awarded to anyone from any part of the world who, in the view of the Council, has rendered particularly distinguished service to the industry. The award will be made not more than three times in ten years. The first award, to be presented at the Society's annual general meeting in London on October 22, is being made to Dr. Richard Seligman, who has been responsible for many developments of outstanding and world-wide importance in the dairy industry.

The Council of the Society has elected Mr. James Mackintosh, lately principal livestock husbandry officer, South-Eastern Provinces, National Agricultural Advisory Service, and formerly head of the Dairy Husbandry Department of the National Institute for Research in Dairying, and Mr. E. B. Anderson, lately chief chemist of United Dairies, Ltd., to be honorary members of the Society of Dairy Technology, in recognition of their services to the dairy industry and to the Society.

## Announcements

APPLICATIONS are invited for the Gabriella Zuccar research grant of 250,000 lire for work at the Zoological Station of Naples for at least six months during 1952. The grant may be renewed for a maximum of three years. Applications, including an outline of the proposed investigation, should reach the Rector, University of Padua, by October 31.

THE twenty-sixth annual conference of Aslib will be held at Ashorne Hill, near Leamington Spa, during October 5–8. The programme will include such subjects as the training and organization of staff, including voluntary workers and students; what can be learnt from industrial efficiency methods, such as job analysis, time and motion study, etc.; and practical bibliographical and documentary projects in operation in the international field, with special reference to the part of Unesco in them. Opportunities will be provided for groups to discuss subjects in their particular field of interest. Further details can be obtained from Aslib at 4 Palace Gate, London, W.8.

THE United Nations Department of Public Information has now issued a 36-page pamphlet, "World Facts and Figures" (New York: United Nations; London: H.M. Stationery Office, 1951. 25 cents; 1*s.* 9*d.*), giving some cogent facts about population, production, including coal and petroleum, electrical energy, steel, strategic metals, cement, rubber, sulphuric acid, transport and communications, medical facilities and newspapers. These are taken from second editions of the "United Nations Statistical Year Book" and "Demographic Yearbook". The facts included are sufficiently comprehensive for the pamphlet to provide the ordinary man or woman with a convenient means of keeping some current discussions on a factual basis.

# EGG-SHELL FORMATION IN TREMATODES AND CESTODES AS DEMONSTRATED BY THE METHYL OR MALACHITE GREEN TECHNIQUES

By Dr. J. D. SMYTH
Department of Zoology, Trinity College, Dublin

DURING recent work on cestode physiology, it was observed that two chemically related dyes —methyl green and malachite green—showed a very marked affinity for the material which formed the egg-shell in certain Diphyllobothriidæ. Further observations revealed that the egg-shell in trematodes possessed a similar affinity.

The essentials of the method, which have been published in detail elsewhere[1], involve fixation of worms in 5 per cent formol-saline and staining of sections in 0·5 per cent aqueous methyl or malachite green, combined with a red nuclear counterstain where necessary. It is stressed that these stains are made up in pure aqueous solution, free from acetic acid—the latter converting them into precise nuclear stains, in which form they are usually used in animal cytology.

These stains have been found to be absolutely specific for shell material, and stain it a brilliant green (malachite green) or greenish-blue (methyl green). Thus, any gland, tube or duct containing shell material may be readily identified in sections.

The method greatly simplifies investigation of the mechanism of egg-shell formation in these groups, as the egg-shell material may be traced from its origin to its final moulding into a typical shaped egg in the lower part of the uterus.

*Egg-shell formation in Trematodes.* It has long been realized that in trematodes the shell material is produced not in the 'shell' gland (Mehlis's gland), but in the so-called 'vitelline' glands ('vitellaria'). The evidence for this view has been ably summarized by Stephenson[2], who has also shown that the egg-shell material is an ortho-dihydroxyphenol-protein complex. The function of the Mehlis gland remains obscure and a number of views have been put forward; the most recent—that of Stephenson[2]—suggests that the main function of the gland is to produce a fluid which increases spermatozoan activity.

Application of the methyl or malachite green techniques confirms and demonstrates clearly the origin of the shell material in cells of the 'vitelline' glands, as spherical globules (*S*, Fig. 3) which stain specifically and intensely in these stains. Not all the cells produce shell at the same time, but in each acini inactive cells free from shell occur (*I*, Fig. 3). Due to the presence of the shell globules in the 'vitelline' glands, these glands stand out clearly in sections from the surrounding tissue (*VG*, Fig. 1). The 'vitelline' cells, loaded with shell globules, may easily be traced along the 'vitelline' ducts and into the lower uterus where, on meeting the ova, they release the contained shell globules, which fuse, to become moulded into typical shaped eggs.

*Egg-shell formation in Cestodes.* The pseudophyllidean cestodes are characterized by possessing shelled eggs similar to those of digenetic trematodes and, also, numerous 'vitelline' glands. The general arrangement of both male and female genitalia also closely resembles that of digenetic trematodes. It might be speculated, therefore, that the eggs in this group of cestodes would be formed in a manner similar to that in the trematodes. Due, no doubt, to the fact that the genitalia in cestodes are smaller and more compressed—being confined to the limits of a proglottid, whereas a fluke of much larger size contains only one set of genitalia—the mechanism of egg-shell formation in this group of cestodes has never been worked out.

Nevertheless, evidence from recent physiological work has strongly suggested that the egg-shell in pseudophyllidean cestodes originates in the 'vitelline' glands. Thus, when such worms are removed from the host gut, they appear colourless; but on exposure to air, the eggs darken rapidly (as in trematodes) and the 'vitelline' glands likewise take on a brown colour. Again, when the pseudophyllidean cestode, *Schistocephalus solidus*, is cultured to maturity *in vitro* under aerobic conditions (that is, with a stream of air passing through the culture medium), the 'vitelline' glands darken rapidly as maturation approaches and only a few shell-less or very abnormal eggs are produced[3,4]. Such phenomena could be

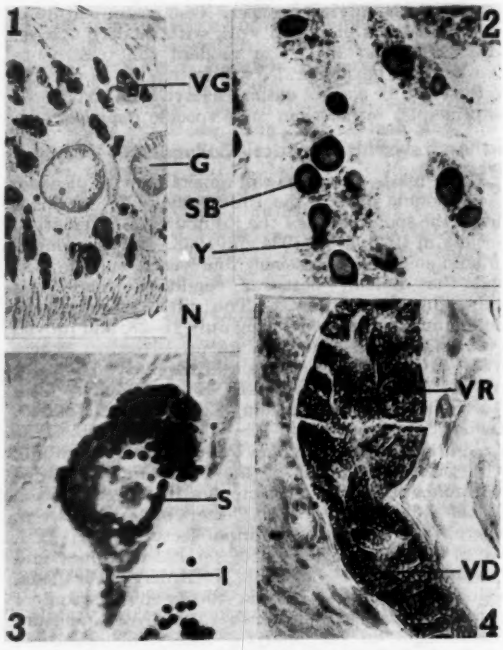


Fig. 1. T.S. *Fasciola* (methyl green)
Fig. 2. T.S. Lower uterus of *Diphyllobothrium* (methyl green)
Fig. 3. 'Vitelline' cells of *Fasciola* in 'vitelline' glands (malachite green)
Fig. 4. 'Vitelline' reservoir and duct of *Schistocephalus* (methyl green). All material fixed formol-saline. *G*, gut; *I*, inactive cell; *N*, nucleus; *S*, shell globules; *SB*, shell blebs; *Y*, yolk; other letters as in *Fig.* 5

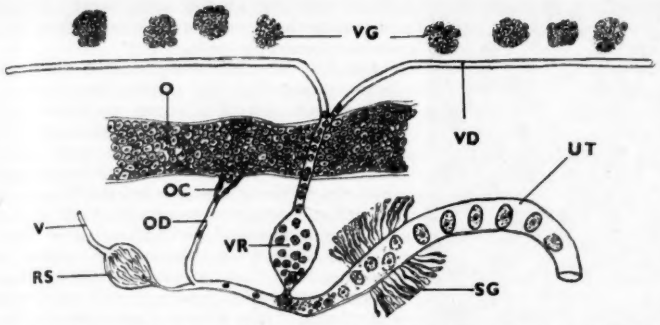


Fig. 5. Diagram of female genitalia in proglottid of *Schistocephalus* to illustrate method of egg-shell formation. *O*, ovary; *OC*, oöcapt; *OD*, oviduct; *RS*, receptaculum seminis; *SG*, 'shell' gland (Mehlis's gland); *UT*, uterus; *V*, vagina; *VD*, 'vitelline' ducts; *VG*, 'vitelline' glands; *VR*, 'vitelline' reservoir

explained by the supposition that the shell material is being produced in the 'vitelline' glands; but due to the high oxygen tension it becomes prematurely tanned and hardened so that the shell globules are unable to fuse together to form proper shaped egg-shells. Although such experimental evidence was highly suggestive, it was not previously possible to confirm such speculations by histological methods.

Application of the methyl and malachite green techniques has enabled the egg-shell formation in three members of the Diphyllobothriidæ—*Schistocephalus solidus*, *Ligula intestinalis and Diphyllobothrium* sp.—to be demonstrated histologically with little difficulty.

After staining, the presence of large, bright green globules in the cells of the 'vitelline' glands may be immediately recognized. As these cells pass down the 'vitelline' ducts (*VD*, Figs. 4 and 5) through the 'vitelline' reservoir (*VR*, Figs. 4 and 5) and into the lower uterus, they release the contained shell globules which here fuse together to form the typical oval egg-shell which encloses a fertilized ovum and some 'yolk' (the remains of the 'vitelline' cells which now only contain nuclei and small pink-staining granules). The 'vitelline' glands thus provide both shell and yolk material to the fertilized ovum. In *Ligula*, the process of egg-shell formation is identical with that in *Schistocephalus*. In *Diphyllobothrium*, the shell globules fuse to form larger globules (*SB*, Fig. 2) before finally forming a moulded egg-shell, and these large globules stand out clearly from the yolk in the lower uterus. It may be remarked that I had been attempting to work out the mode of egg-shell formation in the *Diphyllobothriidæ* for the past five years without success. From sections stained in methyl green, it was possible to trace out the entire process in a matter of a few hours.

*Position of cyclophyllidean cestodes.* The cyclophyllidean cestodes differ from the pseudophyllidean cestodes in that their eggs lack an external egg-shell—the so-called "egg-shell' being, in fact, merely a thickened embryophore. This lack of an external egg-shell is clearly correlated with the absence of a free-swimming larval stage—such as occurs in the pseudophyllidean cestodes and trematodes—from the cyclophyllidean life-cycle.

On theoretical grounds, therefore, it was speculated that the 'vitelline' glands in cyclophyllidean cestodes would be free from globules of shell material and concerned only with the production of yolk material. Investigation of the histology of the 'vitelline' glands of *Tænia saginata* by the methyl green technique has confirmed this hypothesis—the 'vitelline' cells being quite free from shell material and acting as yolk producers only.

There is thus a marked distinction between the 'vitelline' glands of these two groups of cestodes—one type producing yolk alone, the other both shell and yolk. To retain the term 'vitelline' glands for both only introduces confusion. With the present terminology, students are informed that the 'vitelline' glands produce shell, and the 'shell' gland does not—an unfortunate and confusing state of affairs. In order to clarify this position, it is proposed that the use of the term 'vitelline glands' or 'vitellaria' should be restricted to glands that produce only yolk (that is, in the Cyclophyllidea). For glands that produce both yolk and shell (that is, in the trematodes and pseudophyllidean cestodes) it is suggested that a new term—*vitellocalycal* glands—be introduced. The term 'shell gland' should be dropped entirely and replaced by 'Mehlis's' gland—as, indeed, is the increasing tendency in recent text-books of helminthology—until its function has been established.

I am indebted to the Medical Research Council of Ireland for financial assistance towards the expenses of this work. [April 2.

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# EFFECTS OF A PROTEIN-FREE DIET ON THE ALKALINE AND ACID PHOSPHATASE ACTIVITY OF THE LIVER OF THE RAT

By J. O. ELY and M. H. ROSS
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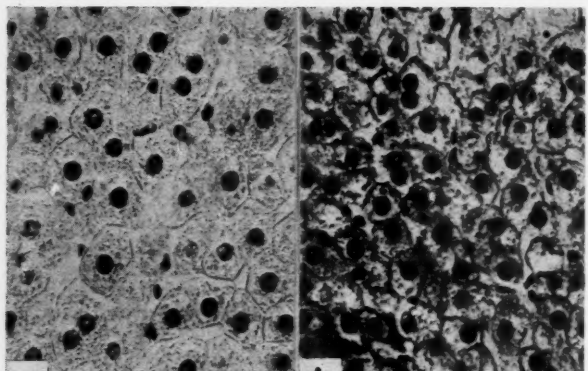
PROTEINS, phospholipids and ribonucleic acids are lost rapidly from the livers when rats are fasted[1,2] or fed a protein-free diet[3]. It was suggested by Perlmann and Ferry[4] that acid phosphatase is a water-soluble protein, and alkaline phosphatase is a water-insoluble, salt-soluble globulin. Loss of protein from the liver because of a restricted dietary protein intake from any cause might alter the phosphatase activity. If this be true, any experiments on the effects of various agents on phosphatase activity should take into consideration the effect of the experimental regime on the food intake of the animals.

The effects of a protein-free diet, in contrast to an adequate diet, on the alkaline and acid phosphatase activity of the liver of rats have been investigated by chemical and by cytochemical methods.

*Experimental.* Male rats of the Wistar strain, 150 gm. initial weight, were maintained on (1) a protein-free diet (dextrose, 89 gm.; corn oil, 5·0 gm.; salt mixture, 4·0 gm.; rice bran extract ('Vitab'), 2·0 gm.; riboflavin, 0·2 mgm.) and (2) Fox Food Blox diet (Allied Mills). At intervals of from five to forty-nine days, rats from each group were de-




Phosphatase activity in sections of livers of rats. The photographs for each phosphatase were prepared under identical treatment, exposure and development time. Magnification × 530. (*a*) Alkaline phosphatase activity in section from liver of rat fed Fox Food Blox diet for 49 days. (*b*) Alkaline phosphatase activity in section from liver of rat fed protein-free diet for 49 days. (*c*) Acid phosphatase activity in section from liver of rat fed Fox Food Blox diet for 49 days. (*d*) Acid phosphatase activity in section from liver of rat fed protein-free diet for 49 days

capitated, and samples of liver weighing 0·1–0·2 gm. were removed and were ground with sand and distilled water. After standing for 30 min. at 15° C. in 5 c.c. of distilled water the suspension was filtered through No. 1 Whatman filter paper; the filtrate was used for the chemical estimation of phosphatase. Chemical determinations of alkaline phosphatase activity were made by the method of King and Armstrong[5] and of acid phosphatase activity by the method of King and Armstrong as modified by Gutman and Gutman[6].

Cytochemical determinations of alkaline and acid phosphatase activity were made by the methods of Gomori[7,8]. For alkaline phosphatase activity determinations thin pieces of liver from the rats of each dietary group were treated alike during the process of fixation (80 per cent ethyl alcohol) and dehydration. For acid phosphatase activity determinations the tissues were fixed in acetone for two hours, and were then dehydrated and embedded in paraffin; the whole process was completed in seven hours. A specimen from each dietary group was embedded in the same block of medium so that sections to be compared were cut at the same stroke of the microtome knife and were mounted on the same microscopic slide.

*Results.* The filtrates prepared from the livers of rats fed the protein-free diet exhibited per unit of nitrogen approximately twice as much alkaline phosphatase activity, and approximately the same acid phosphatase activity as did the filtrates prepared from the livers of the rats fed the Fox Food Blox diet (see accompanying table).

The cytochemical demonstration of phosphatase activity in microscopic sections of tissue showed that the alkaline phosphatase activity was much greater in both nuclei and cytoplasm of the livers of the rats fed the protein-free diet than in the livers of the rats fed the Fox Food Blox diet (Figs. *a* and *b*). Acid phosphatase activity, however, was much less in the nuclei and cytoplasm of the livers of the protein-free diet fed rats than in the livers of the rats fed the Fox Food Blox diet (Figs. *c* and *d*). The photographs show also that the nuclei are more numerous in equal areas of the sections, and, therefore, in equal volumes of tissue, from the livers of the rats fed the protein-free diet than from the livers of the rats fed the Fox Food Blox diet.

*Discussion.* The results of the chemical and cytochemical estimations of alkaline phosphatase activity are in agreement; that is, both methods showed greater enzyme activity in the livers of the rats fed the protein free diet. The results of the acid phosphatase determinations are not in agreement; cytochemically, there was less acid phosphatase activity in the sections from the livers of the rats fed the protein-free diet and no significant difference in the activities per unit of nitrogen in the filtrates. It appears, therefore, that in the filtrates from the livers of the rats fed the protein-free diet a greater amount of enzyme was associated with a unit amount of nitrogen than in the filtrates from the livers of the rats fed the Fox Food Blox diet. This, it seems, indicates that during protein depletion rat liver loses less non-enzyme nitrogen than enzyme nitrogen (acid phosphatase).

It is of interest that the alkaline phosphatase activity in the nuclei of the livers of the rats fed the protein-free diet was greater than in the nuclei of the livers of rats fed the Fox Food Blox. It was shown recently[9] that under similar conditions the feeding of a protein-free diet was followed by an increase in the deoxyribonucleic acid content of the nuclei of rat livers. Brachet and Jeener[10] and Brachet[11] state that a direct parallel exists between

Phosphatase Activity of Extracts of Livers of Rats Fed Different Diets

| No. of rats | Days on diets | King–Armstrong units of alkaline phosphatase per 100 mgm. of nitrogen | | Units described by Gutman and Gutman) of acid phosphatase per 100 mgm. of nitrogen | |
|---|---|---|---|---|---|
| | | Protein-free diet | Fox Food Blox diet | Protein-free diet | Fox Food Blox diet |
| 19 | 5–32 | 54±5·7* | 25±3·4 | 243±29·4 | 263±38·0 |

* Standard error of mean.

the rate of turnover of the phosphate in deoxyribonucleic acid and the amount of alkaline phosphatase of the nuclei. The experiments reported here seem to indicate a parallelism between the alkaline phosphatase activity and deoxyribonucleic acid content in nuclei of rat liver; the rate of phosphorus turnover, however, is not known.

The changes in phosphatase activity found in these experiments apparently are much greater than those previously reported for rat livers. Wachstein[12] found a slight decrease in acid phosphatase activity during protein depletion, and a moderate increase in alkaline phosphatase after 6–18 days on a protein-free diet.

Both the alkaline and acid phosphatase contents of the liver appear to be significantly influenced by protein intake. It would seem important to take this fact into consideration in both the planning and the interpretation of experimental work.

*Summary.* Alkaline phosphatase has been shown chemically and cytochemically to be increased in both nucleus and cytoplasm during protein depletion produced in rats by the feeding of a protein-free diet. Acid phosphatase, on the other hand, has been shown cytochemically to be reduced in both nucleus and cytoplasm. Other proteins of the liver are apparently reduced to a greater extent than acid phosphatase. [April 2.

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# OPTICAL ROTATION AND CHAIN FOLDING IN SYNTHETIC POLYPEPTIDES AND GELATIN

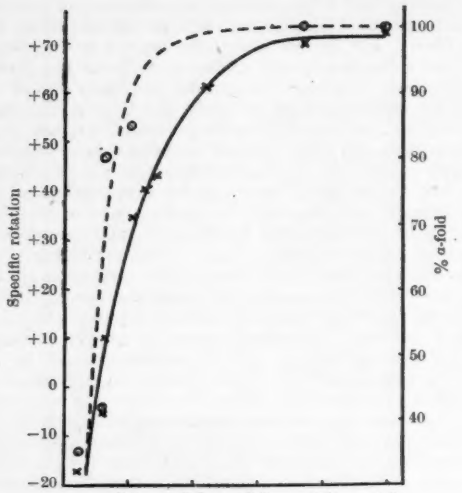
By Dr. CONMAR ROBINSON and M. J. BOTT
Research Laboratory, Courtaulds, Ltd., Maidenhead

IN a chain of atoms containing asymmetric carbon atoms, movements of groups of atoms in the chain relative to those asymmetric carbon atoms would be expected to affect the magnitude and even the sign of the optical rotatory power. Further, if such movements involved in a change of configuration result in ring formation, the consequent reduction of free rotation may also be expected to increase greatly the optical rotation. Recent work in this Laboratory has indicated that the 'α-keratin' configuration of the polypeptide chain is produced by folding the extended β-form into seven-membered rings, held together by intra-chain hydrogen bonds[1,2]. It follows that the $\alpha \rightleftarrows \beta$ transformation would be expected to be accompanied by a change in the specific rotation.

We have recently made some experiments with a synthetic polypeptide (γ-methyl-L-glutamate D-L phenylalanine copolymer). If the molecular weight is not too low, films prepared by evaporating *m*-cresol solutions of this polymer are found to be in the α-form; but as the molecular weight is decreased, there is an increasing tendency to form the β-configuration (compare the similar tendency found for small polypeptides by Bamford, Hanby and Happey[3]). Samples having different molecular weights were prepared and their specific rotations in *meta*-cresol were measured. A rough estimate of the percentage α-fold in the films obtained by evaporation of the solutions was obtained by making use of the fact that the CO-stretching frequency has a characteristic value for both the α- and β-configurations. The results, together with the specific viscosities of the 1 per cent solutions, are shown in the accompanying figure. It will be seen that there is a striking relationship between the specific rotation of the solutions and the percentage of the α-configuration in the films prepared from them. That the differences in specific rotation are not a *direct* effect of molecular weight can be seen by examining solutions of the same polypeptides in formic acid. Here the specific rotations fall between −14° and −18° for the whole range of molecular weights, while the films prepared from these formic acid solutions all show between 60 and 75 per cent of the β-fold. It seems, therefore, reasonable to assume that the changes in specific rotation in *meta*-cresol solutions are largely determined by changes in the proportions of the α- and β-configuration.

The results suggested that it would be possible to use the optical rotatory power as an indication of the change of configuration in protein solutions. Some interesting results have been obtained with gelatin. As is well known, on cooling a gelatin solution from above 35° C. to room temperature, the specific rotation approximately doubles in value. This mutarotation is closely connected with the gelling properties, and it has been suggested more than once that there are two forms of gelatin, one stable above approximately 35° C. and one which is only found below this temperature. Collagen, and gelatin in a film obtained by cold evaporation, have a characteristic configuration which is neither the α- nor the β-fold. This is shown not only by the X-ray diagrams but also by polarized infra-red absorption by oriented specimens. Ambrose and Elliott have proposed a configuration which is in conformity with these data, in which the fold is held together by *inter*-chain hydrogen bonds[4]. The collagen fold has a characteristically high N—H stretching frequency of 3,330 cm.$^{-1}$ as compared to 3,305–3,310 cm.$^{-1}$ for the α- and β-folds in other proteins, and this may be used to identify it in unoriented specimens.

Two 5 per cent solutions of gelatin (*p*H 6·8) were prepared and kept at room temperature and 40° C. respectively. After three days the specific rotation of the cold solution had become almost steady at −262°. The hot solution, which reaches equilibrium rapidly, had a specific rotation of −128°. The specific rotation of a film prepared by evaporation of the hot solution had almost the same value as the hot solution and did not change within twenty-four hours after cooling. On the other hand, a film prepared from the cold solution by evaporation at room temperature showed a rotation (*c.* −1,000°) which was very much higher than that of the corresponding cold solution. These results indicate that we have succeeded in obtaining the hot form of the gelatin in a 'frozen' state which was suitable for studying at room temperature. The N—H stretching frequencies of the




× - - -, specific rotation ; ○ - - -, per cent α-fold

hot and cold evaporated films were found to be at 3,310 cm.$^{-1}$ and 3,330 cm.$^{-1}$ respectively.

These values suggest that the collagen fold is not present in the hot evaporated film ; but unfortunately the data do not allow us to decide whether this film is in the α- or the β-configuration. The results, however, allow us to put forward a tentative picture of the gelling mechanism. Above 35° C. gelatin would appear to exist in a form which does not allow hydrogen bonds to exist between the molecules. This condition would be satisfied either by the α-fold or by a β-fold preferentially forming hydrogen bonds with the water. On concentrating such a hot solution there is little change in the optical rotation, which strongly suggests that it is in the α- rather than in the β-configuration. Below 35° C. the existence of the collagen fold becomes possible where lengths of parallel chain come into contact ; a three-dimensional network is built up consisting of lengths of single molecules joined together by small regions of parallel chains in the collagen configuration (the presence of more than 20 per cent proline and hydroxy-proline means, however, that there will be many residues which cannot be hydrogen-bonded in the α-fold). Where the concentration and number of collagen folds cross-linked are sufficiently high, the network will permeate the whole solution, which will then set to a gel. On ageing, the organized regions in the collagen fold increase ; this will continue until steric restrictions prevent the further growth of the organized regions. The ageing is accompanied by an increase in specific rotation and rigidity. On concentrating the gel there is a further large increase in the proportion of collagen fold, as indicated by the further marked increase in the optical rotation.

In attributing the origin of the gel formation to the formation of the collagen fold, we are assuming that any contribution from side-chain interaction will be of secondary importance. This is in accordance with the observation that the optical rotation[6] as well as the melting point[6] and rigidity[7] of the gel are little dependent on $p$H.

If increasing quantities of certain salts (for example, lithium bromide, iodide or thiocyanate) are added to a cold gelatin solution, the specific rotation falls to a limiting value which is very near that for the hot solution, while at the same time gel formation is prevented[8]. It would seem that high concentrations of such salts convert cold gelatin from the inter-chain-hydrogen-bonded form to the intra-chain-hydrogen-bonded α-form. It is significant that lithium bromide, as Ambrose, Bamford, Elliott and Hanby[9] have shown, converts silk from the inter-chain-hydrogen-bonded β-form to the water-soluble α-form.

Our thanks are due to Mr. E. J. Ambrose for having first directed our attention to the fact that a correlation between optical rotation and the chain configuration in polypeptides was to be expected from theories of optical rotatory power, to Dr. A. Elliott for obtaining the infra-red radiation data on gelatin, and to Mr. N. B. Abbott for that on polypeptides. We also wish to thank Mr. W. E. Hanby for preparing the range of polypeptide specimens.

[March 7.

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## A HUNDRED YEARS OF ORGANIC CHEMISTRY (1851–1951)*

THE century 1851–1951 has been an eventful one for organic chemistry. Indeed, it has seen the science grow from a rather confusing and empirical body of facts into one of the most systematic and fascinating of the sciences, and one on the progress of which many of the amenities of our modern civilization depend.

1851 might almost be regarded as a turning point in organic chemistry, for major developments destined to shape the whole course of the science were at hand. It will be recalled that early in the nineteenth century Berzelius had defined organic chemistry as the chemistry of substances produced by living matter, in contradistinction to the inorganic substances of mineral origin. There were certain striking differences between the two types, and in Berzelius's mind, as in those of his contemporaries, these were associated with the vital force concept. Wöhler's laboratory synthesis of urea in 1828 is generally believed to have sounded the death knell of the vital force theory ; but, in fact, it survived for long after that and it still rears its head in the famous text-book of Gmelin (1854). In the years that followed Wöhler's discovery, however, Liebig and others had shown that the organic compounds all contained carbon and that carbon compounds with similar properties could be obtained from non-living sources, for example, coal tar. So it gradually came to be recognized that organic chemistry was, in effect, synonymous with the chemistry of the carbon compounds, and attention was directed to the understanding of carbon chemistry, since it was clear that

* Substance of a paper read by Prof. A. R. Todd, F.R.S., before Section B (Chemistry) of the British Association on August 9.

until such an understanding was obtained little progress was to be expected in studying the chemistry of living matter.

By 1851 the efforts of many chemists had produced a substantial body of factual knowledge; but despite type theories and radical theories, there was no really satisfactory theory of valency which could correlate the facts and establish the interrelationships of organic compounds. In 1852 E. Frankland made the first clear statement of the idea of valency or fixed combining power of an element. This was a great step forward, and it was followed in 1858 by the work of Kekulé and Couper, who independently put forward a theory of molecular structure based on the quadrivalency of carbon and the capacity of carbon atoms for joining together in chains; they showed how molecular constitution could be represented diagrammatically in graphic formulæ and could predict the existence of isomers. That more isomers did, in fact, exist than were allowed for by this theory was, however, clear from the earlier work of Pasteur, who had shown that two optically active tartaric acids exist. This was clarified in 1874 by van 't Hoff and Le Bel, who added to the Kekulé–Couper ideas the concept of the tetrahedral carbon atom and thereby introduced the idea of space- or stereo-isomerism. With this the whole subject was placed on a firm basis, and on these theories virtually the whole of the modern science arose. Only in comparatively recent years have alterations in basic ideas of molecular structure come from physics through knowledge of the electronic structures of atoms, but even these new ideas have not altered the essential applicability of theory laid down between 1850 and 1874.

Armed with this understanding of structure, the study of the carbon compounds flourished exceedingly, and by the early twentieth century a vast number of such compounds were known and methods of synthesis and analysis had been developed in great variety. During this period, too, began the rise of the great organic chemical industry—producing dyestuffs, starting from the initial aniline dye of Perkin, explosives, etc. This rise of an industry notable for its closeness to the advancing front of a science has continued, until to-day it produces not only dyes and explosives, but also plastics, detergents, photographic materials, drugs, fabrics and a multitude of other things which we accept without question as part of everyday life—there are indeed few of the material comforts of life which do not owe something to organic chemical industry.

The twentieth century has seen, however, a remarkable development in our knowledge of chemistry in relation to living matter. During the latter half of the nineteenth century organic chemists paid scant attention to this side of their subject, and even biochemists—those concerned primarily with the nature of the processes going on in living matter—were relatively few. It is only in this century that great strides in biochemistry have been made.

From the organic chemist's point of view, this was inevitable. The materials found in living matter were too complex for him to study with success until he had mastered the groundwork and developed methods for studying carbon compounds in general. This mastery came from the work of the late nineteenth century, and as the twentieth begins we can see the beginnings of a move towards the goal of the early organic chemists in the work of Fischer, Willstätter and others on the proteins, purines, sugars, natural colouring matters and enzymes. This movement has grown continuously, receiving enormous impetus through the development of micro-techniques enabling work to be done with tiny quantities of material; and in the past twenty-five years it has given most of the spectacular achievement of organic chemistry in the structural elucidation and synthesis of hormones, vitamins, alkaloids, natural colouring matters, etc., and indirectly of the synthetic drugs. Parallel with it have come the developments in the understanding of the finer details of molecular structure and reactivity associated with the names of Lapworth, Robinson, Pauling and Ingold. The welding together of the results and ideas emerging from these two fields of endeavour promise still more striking triumphs for organic chemistry in a future which should be as fascinating as its past.

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# VERTICAL MIGRATION OF PLANKTON ANIMALS*

MANY of the small plankton animals in the sea which are important as the food of fish such as herring, sprat and mackerel swim upwards towards the surface in the evening and down again to deeper levels after dawn. It is of interest from a purely biological point of view to find out what are the factors which govern these movements, and may also be useful in reaching a better understanding of the shoaling of the herring. The plankton consists of small animals of many different kinds, small jellyfish, worms and molluscs, hosts of small crustaceans and many others; they nearly all show this nightly vertical migration upwards. Since it has been developed in so many different groups of animals and must use up so much energy every day—some of them climbing more than a hundred feet—it must clearly be of profound significance in their lives. We do not yet understand its meaning and are still only in the stages of studying the actual movements of the animals in relation to different conditions of light, temperature, pressure, etc.

Hitherto it has not been possible to see animals making extensive vertical migrations in the laboratory or to experiment with them while doing so. Now apparatus has been devised which allows this to be done. A curved transparent tube of 'Perspex', of 2 in. by 1½ in. cross-section, is made to form a complete circle of 4-ft. diameter and is then mounted as a wheel; a small opening, which may be sealed up, allows it to be filled with water and the experimental animal added. The wheel is now turned so that the animal is half-way up one side; it can now swim up or down according to the varying conditions of light, etc., which may be controlled; but as it does so the wheel is turned so that it is actually kept stationary in relation to the observer. It is seen that the animal is swimming in an endless tube; it can swim up and up, or down and down for hundreds of feet, and the wheel, which is turned all the time, automatically records its speed of swimming on a recording drum. Inside the tube are small doors, some with weights and some with floats, which automatically open and close as the wheel goes round; they are always wide

*Substance of a paper read by Prof. A. C. Hardy, F.R.S., and R. Bainbridge before Section D (Zoology) of the British Association on August 10.

open at the side at which the animal is swimming and so do not interfere with it, but closed on the other side to ensure that the water turns exactly with the wheel.

A parallel tube fitted with a photo-electric cell records the light intensity at a point beside where the animal is swimming. The experiments are performed with the wheel in a small glass greenhouse and the intensity of the light varied from bright daylight to complete darkness by a series of white, grey and black screens which can be drawn over the top.

Tracings from the recording drum of the swimming up and down of different animals under different conditions were shown and discussed. *Calanus*, a crustacean, almost the size of a grain of rice and the principal food of the herring, is shown to be able to climb 50 ft. in one hour, and another larger crustacean, *Meganyctiphanes*, almost an inch long, can climb as much as 305 ft. in the same time.

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## APPLICATIONS OF PLASTICS

At the British Plastics Convention and Exhibition held in Olympia, London, during June 6–16, the plastics industry was given full opportunity for displaying its products and discussing the technical and practical aspects in the Convention Hall. The industry can claim considerable credit for the display. This relatively new and virile industry is one which uses its chemical raw materials in a careful and efficient manner to produce a very wide range of products and articles which are proving of much benefit to many industries to-day. They enable new assessments to be made of many old problems and processes; new values of durability, resistance to chemical attack or corrosion under atmospheric conditions, beauty and often lower-cost production resulting from their adoption. There is a large range of plastics materials available, and each one of the materials has itself an almost limitless range of applications best suited to its chemical and physical properties. There is in the lighter industries a very considerable scope for their adoption for very many uses.

The various plastics raw materials will be described first, and a few of their chemical and physical properties named. Then some of the outstanding applications for each plastic dealt with in the Exhibition and the Convention will be mentioned. Plastics materials are either moulded or otherwise fabricated into the many articles or other finished products used by the consumer, who may be the public, or the manufacturer of other products used in another industry. It should be stated here that the plastics materials referred to are the organic plastics only, but by common consent in the industry, rubber is excluded from the range.

*Celluloid* (*or Nitrocellulose*), *discovered in* 1865. This is the recognized pioneer material. It is thermoplastic, which means that after it has been shaped while it is hot, it is rigid when cold. But it will soften again on reheating and it can then be reshaped. Although it is the oldest plastic, it still has many uses which would not be improved upon by more modern materials, for example, table tennis balls, covering stretched over metals, such as automobile steering wheels and omnibus rails, hairbrush backs and toothbrush handles, etc. Its inflammability, however, necessitates its use with caution. In its sheet or rod form it is remarkably tough, while, of course, it is unaffected to a large degree by water and many chemicals.

*Cellulose Acetate, discovered in* 1865. This non-inflammable grade of plastic replaced celluloid for some uses where inflammability was feared. It is a thermoplastic. It came into prominence during the First World War as an aeroplane 'dope'. After that War ended, large stocks were available for utilization, when the process of converting the white powdered cellulose acetate into sheet and rod was developed. A new and relatively safe plastic was available for use in such things as lamp-shades, ornamental articles (for personal decoration, such as brooches, etc.), transparent sheet for packaging, astraldomes for aircraft, fountain-pen barrels, moulding powders, etc.

This material is extremely tough in all its forms and can be made in both rod and sheet form and as moulding material, clear, opaque or translucent (for example, tortoiseshell). Among numerous articles for consumer use made from cellulose acetate are fancy goods, door beading, drawer pulls and handles, spectacle frames, ciné non-flam film, packaging, showcards, protective eyeware.

Cellulose acetate is used to quite a large degree as the raw material for cellulose lacquers, extensively used for general decorative applied finishes. It is also used on ships' fittings, such as covering metal handrails, door furniture, etc.

*Casein Plastics, first produced in* 1885. This class of plastics is gradually giving way to more modern materials. It is available in sheet or rod form principally, and its present use is mainly for ornamental buttons for the garment industry, which articles are fabricated by machines from rod or sheet. It is not waterproof in the generally accepted sense of the word.

In addition to buttons, many fancy goods are made from it, such as barrels for pencils and fountain-pens, and insulators and articles for resisting low-tension electric currents. Other applications are shoe buckles, knitting pins, umbrella handles, furniture handles, combs, etc., by machining from rod or sheet.

*Phenolic Plastics, developed in* 1907. This type of plastics is the most extensively used range of materials at present. Phenolic plastics are thermosetting, which means that while hot they may be shaped; but during shaping a chemical reaction takes place which hardens the material in the mould. Further heating does not soften the moulding or shaped piece as in the case of thermoplastic materials. Thus, the finished articles or products made in phenolic plastics may be used for purposes where some resistance to heat is required. Phenolic plastics is only one type of thermosetting material, others being urea-formaldehyde and melamine-formaldehyde plastics (amino-plastics) as described later. The finished articles are extremely hard and, in addition to being resistant to heat, they are also resistant to a wide range of chemicals, but not to alkalis or strong oxidizing agents.

From the resins are made a wide range of products, such as moulding materials, paper and fabric laminated sheets, the more durable types of paints, and varnishes for electrical insulation, units of chemical plant as a structural material, acid-resisting floors, tanks, vats, pipework, etc. Large quantities are used for the manufacture of high-speed grinding wheels, brake and clutch linings for cars, adhesives for ply-

wood manufacture, electric lamp capping cements, metal foundry core binders, etc.

Moulding powders are used to produce large television and radio cabinets in one piece, clock cases, rotary pump impellors, stud-welding pistol grips, car facia boards, Topham spinning boxes and spools for the rayon industry, vacuum cleaner bodies, shop counter drawers, ventilator fan cases and rotors and radio and electrical accessories. In addition, a large range of fancy goods such as cigarette caskets, desk calendars, etc., are produced. The present trend is for larger and larger mouldings to be made.

In its laminated form, using paper or fabric as the interlayer, phenolic plastic is used for plywood facing for furniture, wall panelling for ships and railway carriages, silent gear wheels to transmit both low and high powers, plating barrels, fish plates for railways, stern tubes for the propellor shafts of ships, roller bearings in steel rolling mills, aircraft propellors and structures (for example, the 'Mosquito'), moulded dinghy hulls, etc.

*Amino-Plastics—Urea and Melamine, developed in* 1920 *and onward.* These are thermosetting. Mouldings with a high degree of beauty can be made, and thus they are used for fancy goods to a large extent. Urea resins are used for plywood adhesives, foundry sand-core binders, surface coatings, treatment of textiles to render them resistant to creasing, increasing the wet strength of papers, permanently stiffened finishes for textiles in admixture with starches or dextrins, controlling shrinkage of fabrics.

Urea and melamine resin mouldings are non-tracking, and thus are widely used for certain electrical insulators where resistance to electrical surface leakage is essential.

Amino materials capable of being made in light colours and delicate pastel shades are used extensively for surface layers of laminated sheet for wall panelling and light-coloured materials for furniture finishing, for example, table and bar counter tops, etc.

*Polyvinyl Plastics, developed during* 1920–30. These are thermoplastics made as polyvinyl chloride or acetate or copolymers of chloride and acetate. They are also produced as the acetals, butyrals, etc. They are easily worked into sheets and are now extensively used for shower curtains, window furnishings, flooring tiles and raincoats (either as sheet or as coated fabric). They can be made with a high degree of decoration, either clear or opaque and with printed patterns. They are also used for upholstery (leather-cloth), shoe uppers, ladies' handbags, transparent packaging, etc. In the chemical industry, polyvinyl chloride sheet (known as p.v.c.) is used for tank linings, protective clothing, filter cloths. Other applications are: safety glass for motor-car windscreens, yarns for weaving hosiery, fishing nets, etc., 'cocoon' casing for armaments in storage or being shipped to the East. Very large quantities are used for covering electrical cable instead of rubber, and for the manufacture of highly successful primers and other surface coatings.

*Polyethylene Plastics, developed* 1937–43. They are thermoplastic and possess a very high degree of both chemical and electrical resistance. They are wax-like to the feel and in appearance. They can be used for many items of chemical plant and utensils, such as pipes for conveying many chemicals, and for lining the interior of chemical tanks and vats, containers and utensils for hydrofluoric acid.

The evolution and use of polyethylene contributed substantially to the development of radar during the Second World War, on account of its very low power factor.

It is extensively used as the interior core of undersea cables to reduce electrical losses. It is also used in transparent film form as a packaging material for foodstuffs, drugs (like 'Mepacrin' tablets), flexible bottles by the Plax extrusion blow technique, pharmaceutical tubes, cosmetic containers, etc. Balloons for high-altitude meteorological and other observations can be made of polyethylene. Tubing for cold-water plumbing is also made of polyethylene.

*Nylon, developed during* 1928–38. This is a polyamide plastic and is a thermoplastic. It is best known for its use in hosiery and specialized garments. Industrial applications include tow ropes for gliders and gear wheels for impellor pumps. As a filler for phenolic moulding materials, it imparts great strength and resistance to alkalis and acids in mouldings. It is used extensively for surgical dressings where 'breathing' outwards only is required.

*Methyl Methacrylate, developed in* 1938. This is an ethenoid type of plastic and is thermoplastic. Some of its applications are for use in aircraft as radomes from transparent sheet, transparent models or housings for working parts for use in exhibitions, for example, motor-car engines, gear-box casings, etc. It is also used for artificial teeth and dentures, some types of transparent mouldings, camera lenses, spectacle lenses, sculpture or highly ornamental carvings, and rods for transmitting artificial light round bends. It is a material of considerable beauty and consequently is used for a wide range of fancy goods for machining.

*Polyethylene Glycol Terephthalate* ('*Terylene*'), *developed in* 1939 *and onwards.* This is a true synthetic fibre, either silk-like or wool like in properties. It can be made unshrinkable. It can be easily printed and is probably the most successful synthetic fibre for the textile industry to date. Its tenacity when wet is the same as when dry. It has good drape and handle, and has been used so far for lightweight suits. It is also used for filter cloth and laundry bags, ropes, cord, thread, corset cloth, brassière cloth, industrial overalls and sailcloth. It is expected to follow the pattern laid down by nylon.

The above is a brief outline of the state of the industry up to date; but new products are emerging rapidly and what is new to-day may be old to-morrow.

H. V. Potter

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# LIBRARY SERVICE IN GREAT BRITAIN

## ANNUAL CONFERENCE OF THE LIBRARY ASSOCIATION

As one of the means by which scientific and technical knowledge is made more readily available to industry and to the community generally, the public library service must always be of some general interest to the man of science. While his own needs will be met in general by the libraries maintained by his professional institutions, or of the universities, research institutes or industrial organizations or firms with which he is associated, as well as by such national libraries as those of the Patent Office or the Science Museum, they are already to some extent served by the larger public libraries

which offer a type of regional service. If the regional libraries or services envisaged by the Panel on Technical Information Services of the Committee on Industrial Productivity ever mature, the public libraries are likely to play an important part in the development.

Little hint of such developments was given at the annual conference held in Edinburgh during June 5–8 by the Library Association; but papers presented at the Conference possess rather more than usual interest for the scientific worker. The presidential address of Mr. James Wilkie, for example, dealt largely with the challenge which the impact of science and technology on everyday life as well as on industry make to the librarian, not only to meet the needs of science and technology but also to assist the citizen to adapt himself to changing conditions. These opportunities of service to all sections of the community were indicated with the vision and sure touch to be expected from the secretary of the Carnegie United Kingdom Trust. The same qualities characterize the general report of the Public Library Inquiry conducted in the United States by the Social Science Research Council, with assistance from the Carnegie Corporation, at a request made by the American Library Association in 1948. The findings of this report were summarized for the Library Association Conference by Mr. W. A. Munford, Cambridge city librarian, and it is clear from his summary that, apart from its bearing on public library service in Great Britain, the report deserves attention in regard to adult education and the extra-mural work of the universities, at least as indicating some of the questions that should be answered before determining university policy in that field.

Mr. Munford's paper was presented at a session at which the Association looked to its future problems, and another paper contributed to that session, by Miss Gwenda Jones, dealt with the practical issue of the place of reference and technical libraries in the county library system. This is an aspect of the regional problem which has scarcely yet been faced, largely for reasons of space, staff and of money; but it is one which the distribution or dispersal of industry would render ever more important. Decentralization of industry itself explodes the idea that the county library system is a purely rural service completely divorced from industry and science. Miss Jones herself recognizes that the pattern of a county library technical service may be decentralization to the towns where the main industries operate, and that this would necessitate strengthening the branch staffs with technical librarians, possibly joint appointments with that of reference librarian. It is interesting to note also in this paper the suggestion that the county library system should provide employment for more persons with scientific qualifications of the calibre who at present find a place only in the big municipal libraries or the industrial libraries. Doubtless it will not be easy to implement any such suggestion without considerable improvement in the status and salaries which the county library system can offer at present, but the freer movement of men and women both from the public library system into industrial libraries and in the reverse direction is desirable. It could be an important factor in encouraging that mutual understanding of problems and conditions which is a prerequisite in developing the co-operation between libraries to which a whole session of the Conference was devoted.

The paper on reference libraries presented by Mr. Hargreaves, reference librarian of Leeds, at that session, and the papers at the symposium on library service to industry are possibly those of most interest to the scientific worker. Mr. Hargreaves's paper presented a sane and balanced view of the whole problem of inter-library co-operation in which the point of view of the industrial librarian is very fairly reflected. Mr. Hargreaves sees clearly enough the advantages of building up a co-ordinated system, as well as the practical difficulties in doing so, and no one could have indicated more clearly the way in which any such system can be prejudiced or even wrecked by thoughtlessness in the way it is put to use. Some of his suggestions should be at least as useful to the librarian in industry as to the public reference librarian, and his paper gives also a hint of the extent to which inquiry is still required before any attempt is made to set up a system of regional reference libraries in Great Britain.

The Earl of Elgin and Kincardine, vice-president of the Scottish Council for Development in Industry, who opened the symposium on library service to industry, was concerned to provide a national background for the discussion, and, like Mr. Wilkie, stressed the dominant part of science in industrial production and expansion and the need for efficient library service to enable the scientific worker—and indeed the administrator—to do the best work of which they are capable. He gave, moreover, just a hint of the contribution which library service can make to the task of adult education and the bearing of this not merely upon industrial productivity but also upon the social satisfactions which, as Dr. Elton Mayo emphasized, go so far to determine productivity. That point was also stressed by Mr. L. R. McColvin in his final reference to the importance of preventing the devaluation of man.

Mr. McColvin was referring to the part which the public library can play in providing the real incentive to use our technical powers to improve productivity by helping to make life interesting, to promote understanding and tolerance, to provide relaxation and enjoyment and disclose opportunities. Whatever the public library system can contribute to the dissemination of technical information or the improvement of industrial efficiency is, and should be, secondary to its function as a means of adult education and the provision of social satisfaction. It would be untoward if its resources and energies were diverted from that primary task, and the papers presented at the Edinburgh Conference give grounds for believing that in any re-examination of the place of the public library in adult education or the direct contribution it can make to the dissemination of technical and scientific information, its social function will be kept firmly in mind, and particularly by the men and women responsible for carrying out that service.

That reassurance is supported by the presence in the Civil Estimates of an entry of £2,000,000 for the acquisition of a site for the National Library. Only £50,000 of this sum is earmarked for 1951–52, and the project is thus a fairly distant scheme, like that for the Science Centre, which is also to accommodate the Patent Office and its Library, extended and modernized to constitute a first-rate central reference library on science and technology. Mr. F. C. Francis, in his paper dealing with the place of the libraries of Government departments, learned societies and research institutes in providing a full library service

for industry, indicated that a sub-committee has already completed its report on the scope and plan of the proposed new Central Scientific Reference Library, although the report has not yet been made public. Mr. Francis emphasized, however, that no one library could provide all the service now required, and that the elaboration of scientific library services in Great Britain demands the greatest possible spreading of responsibility. The function of the National Library is to cover the greater part of the field itself and to co-ordinate the activities of the other libraries, seeking to ensure that all fields of information are properly covered.

Beyond the announcement that the proposed Science Centre is to be on a site on the south bank of the Thames, there has been no official pronouncement since Sir Robert Robinson's reference to the scheme in his anniversary address to the Royal Society on November 30, 1950. The site for the National Library has also been chosen, and the Ministry of Works has requested the London County Council to designate for this purpose in its first development plan the area lying opposite the British Museum on the south side of Great Russell Street. It is proposed that eventually the library of the British Museum shall be separated from the museum departments and accommodated in its own building on this site, much as, some seventy years ago, the natural history collections were transferred to South Kensington. Both projects will require many years for completion, and even the detailed planning is scarcely in sight. Nevertheless, Mr. Francis rightly directed the attention of the Library Association to both the short-term and the long-term problems which such projects pose, and to the challenge they offer to constructive thinking as well as to co-operation. That challenge should be taken up by the scientific worker and technologist as well as the librarian, and indeed by all who appreciate the large part which libraries can play in the dissemination and assimilation of our scientific and technical knowledge. As Mr. Francis indicated, prime importance is attached to the whole matter by the Government; but if the opportunities are to be utilized to the full and all obstacles to achievement overcome, the Government will require the sustained support over a period of years of informed opinion in scientific, technical and industrial circles.

## RESEARCH ON BRICK-MAKING

### NEW RESEARCH LABORATORIES OF THE LONDON BRICK CO., LTD.

OVER a large area of Great Britain the fletton brick has won its place as the cheapest common brick of the building industry, and an annual output of more than 2,000 million is nowadays achieved by the group of brickworks situated on the Oxford clay in the districts lying mainly around Bedford and Peterborough. In any manufacturing industry operating on this scale it is to be expected that there would be many problems calling for research, and a notable advance has recently been made by the largest fletton manufacturer, the London Brick Co., Ltd., which has recently opened new research laboratories at its Stewartby works near Bedford. The building, which was designed by Mr. C. C. Handisyde, provides efficient accommodation for the strong research team that has been built up since the War and, in addition, includes a display hall, library, and directors' conference and dining rooms. It is perhaps significant of the changes which are coming about in even the more traditional of our industries that accommodation for the Company's directors should be provided in close association with the research laboratories.

The laboratories are, naturally, built of brick. They are on an ample site and are designed in three wings on one floor on a flexible plan which will facilitate any future extensions that may be needed. Offices and small laboratories open off central corridors, and the lessons of modern school design have been utilized in that the larger laboratories obtain cross-ventilation and additional lighting over the corridors.

Other interesting features are the use of ceiling heating-panels in the laboratories to avoid the loss of valuable wall and floor space which other forms of heating would have required, and the imaginative use of bright, pleasant colours throughout the building in the decorations. Even the service pipes, which, owing to the nature of the site, could not be accommodated in under-floor ducts, are picked out in various colours in accordance with recommendations issued by the British Standards Institution.

Much of the research work is aimed at improving both the understanding and the operation of the manufacturing processes used in the Company's works, and studies are in hand on the conditioning and grinding of the clay, on the methods of pressing it into green bricks, and on the drying and firing processes involved. It is something of a surprise to find a well-equipped fuel technology laboratory devoted mainly to a study of the fuel content of the natural Oxford clay. Theoretically, the organic content of most of the clay used in the works is sufficient to produce all the heat needed for burning the clay. In fact, on account of the unavoidable inefficiencies of the burning process, some additional fuel has to be provided; but this is only a quarter of that needed for burning most other types of bricks. This is a matter of great economic importance in the fletton industry.

As an essential part of the research on plant and methods, a close statistical watch is kept on the qualities of the bricks emerging from the various works. By this means the effects of changes both in the manufacturing processes and in the nature of the raw clay can be accurately followed. Research of this kind is badly needed in a group of industries which are normally regarded as falling outside the field of chemical engineering, and it may well be that this pioneering work by the London Brick Co. will lead other industries to make similar efforts.

Work of a much more fundamental character is also being done. In association with a detailed geological survey of the Oxford clay deposits, a study has been commenced of the constitution of the clay. Differential thermal analysis is being used for the identification of clay minerals, and provision has been made for the utilization of X-ray techniques at a later stage. These are essentially long-term investigations and represent an imaginative and long-sighted view by the Company of its research activities.

In addition to the work concerned directly with brick manufacture, there is also some research in hand on processes designed to produce a light-weight aggregate for concrete by the bloating of clay, and other clay products of cellular structure. Attention is also given to the utilization of by-products.

# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications*

## Mode of Action of Antibiotics in Stimulating Growth of Chicks

THE stimulating effect on chick growth of antibiotics given by mouth has been reported by Stokstad and Jukes[1] and many other workers. Their finding has been confirmed at Reading[2] on several occasions with a variety of diets including practical rations, but not at Greenford, where only practical rations were tested.

The first set of results reported here was obtained independently in the two laboratories. The diet was a practical chick-rearing meal to which procaine penicillin was added to supply 25 mgm. of the antibiotic/kgm. Day-old Rhode Island Red × Light Sussex chicks were used in both laboratories, but were obtained from different sources. Their mean body-weights in grams after three weeks on the diets were :

| Laboratory | No. of chicks/group | Without penicillin | With penicillin |
|---|---|---|---|
| Greenford | 10 (mixed sexes) | 181 | 183 |
| Reading | 20 ♂ | 143 | 191 |

The second experiment was designed to eliminate sources of variation between the two laboratories. One large batch of National Baby Chick Mash was obtained and divided between them. Similarly, equal groups of cockerel chicks (Rhode Island Red × Light Sussex) from the same supplier were distributed to each on the day of hatching, and their housing conditions were made as nearly as possible the same. The chicks were given the experimental diets for three weeks and their mean body-weights in grams at the end of this period were :

| Laboratory | No. of chicks/group | Without penicillin | With penicillin |
|---|---|---|---|
| Greenford | 20 ♂ | 188 | 191 |
| Reading | 20 ♂ | 167 | 192 |

The reasons for this marked discrepancy between results in the two laboratories is being investigated further ; but the findings so far support the suggestion that the growth-stimulating effect of antibiotics results from their suppression of micro-organisms detrimental to the host. It is possible that at Reading, and in other laboratories, where chicks have been kept regularly for a number of years, such organisms may have become established, with a slightly retarded rate of growth as their only manifestation. Chicks are not normally kept in the Greenford laboratories, and it is therefore unlikely that such organisms would be present there. If this explanation proves correct, it could certainly account for some of the dramatic results obtained by many workers with antibiotics in practical poultry management.

Quite possibly, with chicks deprived of the animal protein factor or other vitamins, antibiotics may stimulate growth also by creating in the gut conditions more favourable to the synthesis and uptake of missing factors.

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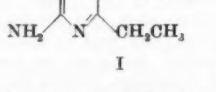
## A 2 : 4-Diamino Pyrimidine in the Treatment of Proguanil-resistant Laboratory Malarial Strains

A SERIES of 2 : 4-diamino pyrimidines substituted in the 5- and/or 6-position has recently been described[1] as having activity against malaria infections of laboratory animals. In particular, 2 : 4-diamino-5-*p*-chlorophenyl-6-ethyl pyrimidine (I), termed 50·63 here, showed a high degree of activity.



I

This compound has been tested against strains of malaria parasites showing experimentally induced resistance to proguanil. Its activity against these resistant strains falls little short of that which it exercises against normal strains.

Three resistant strains were used in these experiments. The proguanil-resistant *P. gallinaceum* was obtained from the Liverpool School of Tropical Medicine and is strain 6 as described by Williamson and Lourie[2]. This strain was tested for proguanil-resistance before proceeding further and was found to be at least 55 times more resistant to the action of proguanil than the normal sensitive strain. (Minimum effective dose for proguanil is 0·9 mgm./kgm. for the normal strain and more than 50 mgm./kgm. for the resistant strain, the minimum effective dose being defined as the dose which effected a 50 per cent reduction in parasitæmia compared with untreated controls, this being estimated graphically from dose-response curves.)

Two drug-resistant strains of *P. berghei* were used: the first a strain which had been subjected to sub-curative doses of proguanil, and the second to sub-curative doses of sulphadiazine. The method of inoculation and dosing is similar to that described by Goodwin[3]. After their respective courses of treatment, both strains were tested for proguanil- and sulphadiazine-resistance along with the untreated parent strain.

It had previously been shown[4] that treatment of *P. gallinaceum* infections in chicks by sub-curative doses of sulphadiazine had very quickly induced a high degree of proguanil-resistance in that strain, even before sulphadiazine-resistance became mani-

Table 1. TESTS OF RESISTANCE ON PROGUANIL- AND SULPHADIAZINE-TREATED STRAINS OF *P. berghei*

| Experiment | Strain | Min. effect. dose proguanil (mgm./kgm.) | Min. effect. dose sulphadiazine (mgm./kgm.) | Degree of resistance* |
|---|---|---|---|---|
| 1† | Parent | 5·2 | — | 3·8 |
| | Proguanil-treated | 20 | — | |
| 2 | Parent | — | 0·07 | 1·1 |
| | Proguanil-treated | — | 0·08 | |
| 3 | Parent | 5·8 | 0·05 | 1·7 for proguanil, 3·2 for sulphadiazine |
| | Sulphadiazine-treated | 10 | 0·16 | |
| 4 | Parent | 5·2 | 0·03 | 3·8 for proguanil, 4·3 for sulphadiazine |
| | Sulphadiazine-treated | 20 | 0·13 | |

* Degree of resistance is expressed as the ratio of the minimum effective dose for resistant strain to that for parent strain.
† Exp. 1: after twelve treated passages. Exp. 2: eight months after exp. 1; strain treated occasionally with maximum tolerated dose of proguanil between experiments. Exp. 3: after seven treated passages. Exp. 4: after nine treated passages.

fest. Table 1, which summarizes these preliminary experiments, shows that the sulphadiazine-treated strain of *P. berghei* has also attained some degree of resistance towards proguanil.

The results in Table 1 also show the proguanil-treated strain to have become resistant to proguanil treatment. The ratio is of necessity small owing to the low activity of proguanil in *P. berghei* infections and its high toxicity to mice. It is also interesting to note that while the sulphadiazine-treated strain had quickly attained resistance to proguanil, the proguanil-treated strain showed no resistance to sulphadiazine. Similar work by Bishop and McConnachie[4] showed that cross-resistance to sulphadiazine by proguanil-resistant *P. gallinaceum* strains is only attained after prolonged treatment with large doses of proguanil.

Using these three resistant strains and the corresponding normally sensitive strains, 50–63 was assayed by methods previously described[1,5] and the minimum effective doses of the compound against each particular strain determined as above (see Table 2).

Table 2. ACTIVITY OF 50–63 AGAINST PROGUANIL-RESISTANT *P. gallinaceum* AND *P. berghei*

| Drug | Strain | Min. effect. dose (mgm./kgm.) | Degree of resistance |
|---|---|---|---|
| Proguanil | *P. gallinaceum*—parent | 0·9 | >55 |
| | *P. gallinaceum*—proguanil-resistant | >50 | |
| | *P. berghi*—parent | 5 | |
| | *P. berghei*—proguanil-resistant | >20 | >4 for 'proguanil strain' |
| | *P. berghei*—sulphadiazine-resistant | 17·5 | 3·5 for 'sulphadiazine strain' |
| 50–63 | *P. gallinaceum*—parent | 0·03 | 2·3 |
| | *P. gallinaceum*—proguanil-resistant | 0·07 | |
| | *P. berghei*—parent | 0·02 | |
| | *P. berghei*—proguanil-resistant | 0·06 | 3 for 'proguanil strain' |
| | *P. berghei*—sulphadiazine-resistant | 0·02 | 1 for 'sulphadiazine strain' |

From Table 2 it appears that cross-resistance does not occur; 50–63 largely retains its high degree of activity against strains which respond little or not at all to maximum tolerated doses of proguanil. Further experiments show that *P. gallinaceum* does not readily become resistant to 50–63 after treatment with subcurative doses of that compound, in direct contrast to the ease with which proguanil-resistance is produced[6,7]. In the present series, an offshoot of the *P. gallinaceum* strain was treated through fourteen successive passages with a total of 95 doses of 50–63 at a dose of 0·04 mgm./kgm., approximately the minimum effective dose. At the end of this course of treatment, the minimum effective dose of 50–63 was determined for both the parent and treated strains (see Table 3).

Table 3. TEST OF RESISTANCE OF PARENT AND 50–63-TREATED STRAINS OF *P. gallinaceum* TO 50–63

| Strain | Min. effect. dose of 50–63 (mgm./kgm.) | Degree of resistance |
|---|---|---|
| Parent | 0·02 | 2·5 |
| 50–63-treated | 0·05 | |

These results indicate the treated strain to be two and a half times more resistant to treatment with 50–63 than the normal strain. Knoppers has shown[8] that treatment of *P. gallinaceum* infections with quinine results after twenty-six weeks in the development of two-fold resistance; further treatment did not result in increased resistance. 50–63 may behave similarly and produce a low degree of resistance not easily increased by further treatment.

A more detailed and extended account of these observations will be published elsewhere.

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## Formation of Extra-cellular Nitrogen Compounds by Fungi

IN the course of work in this Laboratory on the nitrogen metabolism of mould fungi, it has frequently been observed that much less than the total amount of nitrogen supplied initially in the medium in the form of nitrate or ammonium salt is recovered in the fungus mycelium, although a high level of readily assimilated carbohydrate is present in the culture medium. Similar results have been obtained by other workers[1]; but it is not clear whether they are to be explained by incomplete assimilation of the nitrogen source or by the formation by the fungus of complex nitrogen compounds which either remain in, or are excreted into, the medium. A quantitative study of the uptake of inorganic nitrogen by fungi

was therefore undertaken, using in the first place a strain of *Scopulariopsis brevicaulis*.

The fungus was grown in still culture in small conical flasks on a liquid synthetic medium containing 5 per cent glucose (AR), mineral salts, trace elements, and inorganic nitrogen as either potassium nitrate or ammonium sulphate. The ammonia medium also contained 1 per cent sodium succinate, the addition of which has been found necessary to ensure good growth on ammonium sulphate with this particular strain. The nitrogen source was sterilized separately from the other components of the culture medium. Each flask received exactly the same quantity of nitrogen initially. The disappearance of nitrate and ammonia from the medium was followed at intervals during growth of the fungus. Ammonia was determined by titration after distillation in Conway micro-diffusion units. Nitrate was determined as ammonia after reduction by Devarda's alloy. Simultaneous determinations of the total nitrogen in the medium were made by micro-Kjeldahl (nitrate, if present, being previously reduced with iron).

Differences were found between the total nitrogen and the inorganic nitrogen (nitrate or ammonia) in the medium which indicate the formation of extracellular 'organic nitrogen' during the growth of the fungus, as the accompanying figures show.

| Nitrogen source | Amount of nitrogen per flask initially (mgm.) | 'Organic-nitrogen' formed per flask (mgm.) Days 0 | 3 | 4 | 5 | 6 | 7 | 10 | 12 | 15 | 16 | 17 | 23 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $NH_4$ | 6·1 | – | 0·3 | | | | 1·2 | 1·3 | 1·2 | 1·4 | | | 1·5 |
| $NH_4$ | 6·8 | – | 0·3 | 0·7 | 0·9 | 1·4 | 1·6 | 1·4 | | | 1·6 | | |
| $NO_3$ | 6·6 | – | | | | 0·7 | 0·9 | 1·2 | | 1·4 | | | |

The nitrate and ammonia had completely disappeared from the medium by the sixth or seventh day, and it is thus evident that most of the formation of 'organic nitrogen' accompanies the active assimilation of inorganic nitrogen by the young growing mycelium. Thereafter the 'organic nitrogen' remains rather steady, possibly showing a slight tendency to increase. Other experiments have shown that the formation of extra-cellular 'organic nitrogen' takes place over the normal *p*H range at which growth occurs, and also with differing carbon/nitrogen ratios of the starting medium. It also takes place in shake culture, showing that it is not associated only with the special conditions of still culture.

At least 90 per cent of the 'organic nitrogen' is dialysable and therefore does not consist of extracellular enzymes. It gives strong reactions for α-amino-nitrogen when tested with ninhydrin after removal of any free ammonia. Paper chromatography indicates at least two ninhydrin-reacting substances in culture filtrates of the ammonia medium. One of these substances, but not the other, is also present in filtrates of the nitrate medium. These substances have not yet been identified, nor is it known what proportion of the 'organic nitrogen' is amino-nitrogen.

The formation of extra-cellular nitrogen compounds during the assimilation of ammonia or nitrate in the first stages of growth has been shown quantitatively and qualitatively (appearance of ninhydrin-reacting compounds) for a number of other fungi, including strains of *Penicillium griseofulvum*, *P. chrysogenum*, *Aspergillus niger*, *Trichoderma viride* and *Syncephalastrum racemosum*. The phenomenon thus appears to be of general occurrence, as is confirmed by a number of incidental references in the literature[2-4].

These observations are of considerable significance for the general problem of nitrogen metabolism in fungi. They show that the assimilation of inorganic nitrogen by these organisms is normally accompanied by the conversion of a surprisingly high proportion of the available nitrogen (10–20 per cent) into compounds which are not accumulated in the mycelium. The relation of these compounds to the process of assimilation, and whether they are to be regarded as excretion products, or as playing a more essential part, are questions which can only be discussed in the light of fuller knowledge. Further experiments on this problem are in progress and will be reported in detail elsewhere.

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## Photo-inactivation of the Plant Hormone Indoleacetic Acid by Fluorescent Substances

The fact that riboflavin and eosin, which are known to determine the photo-inactivation of indoleacetic acid[2,3], are both fluorescent, led us to investigate whether other fluorescent substances would also be effective in sensitizing such a reaction. Quinine sulphate, æsculin and 2,3,5-triphenyl tetrazolium chloride were tested. It was found by both chemical and biological experiments that these compounds were all active. These substances are colourless, but fluoresce with a visible colour, absorbing light in the ultra-violet region. They are not related chemically, fluorescence being apparently the only property common to them. The present experiments do not necessarily show that there is a direct cause-and-effect relationship between fluorescence and the capacity of inducing the photo-inactivation of indoleacetic acid.

Since many fluorescent substances are of natural occurrence in plants, it seems possible that they play a physiological part in plant growth reactions brought about by light. It also seems that this inactivation of auxin would explain the experimental results of many authors[1] who have treated plants with fluorescent substances.

As to the mechanism of the *in vitro* destruction of indoleacetic acid, it seems that there is always oxidation of this compound, which gives off hydrogen to an acceptor. This can be easily demonstrated by adding a few drops of methylene blue to the reaction-mixture (indoleacetic acid–fluorescent compound). The blue colour disappears within a few minutes of exposure to sunlight. In some instances (sensitization by riboflavin) atmospheric oxygen is required[2]. In other cases (for example, with quinine sulphate), oxygen decreases the reaction-rate. The reason for this is not yet understood.

In the case of catalysis by quinine sulphate, the reaction mixture becomes turbid upon exposure to

light, by formation of a compound with lower solubility in water; this compound is ether-soluble. After evaporating off the ether, there remains a pink-brown residue with a strong smell of fæces.

It is possible that one step of the transformations brought about by light is the formation of skatole, by side-chain degradation of the indoleacetic acid molecule.

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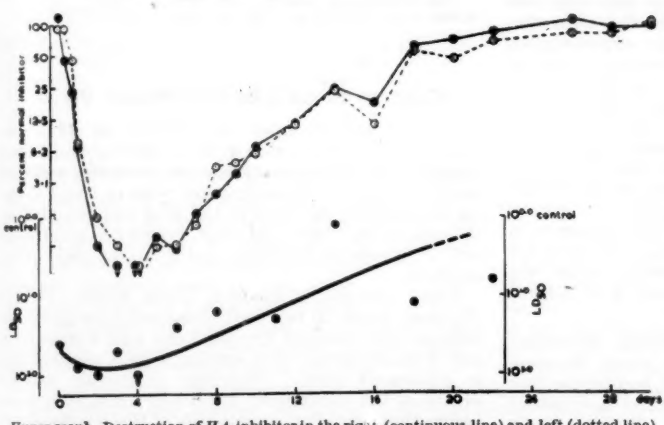
## Protection by Receptor-destroying Enzyme against Infection with a Neurotropic Variant of Influenza Virus

IN 1948, Stone reported that infection by influenza viruses of embryonated hens' eggs after allantoic inoculation[1], and of mouse lungs after intranasal instillation[2], could be prevented by pretreatment of the exposed cells with the receptor-destroying enzyme of *Vibrio choleræ*[3]. It seems worth adding to these observations the finding that death of mice from infection by a neurotropic variant of influenza virus, neuro-*WS*[4], can be similarly prevented by pretreatment of the mice with an intracerebral injection of receptor-destroying enzyme, and that the return of susceptibility to infection, following a single inoculation of receptor-destroying enzyme, runs roughly parallel to the return of inhibitory activity of the brain[5] to influenza virus hæmagglutination.




*Upper graph.* Destruction of *HA*-inhibitor in the right (continuous line) and left (dotted line) cerebral hemispheres, following inoculation of receptor-destroying enzyme into the right hemisphere. *Lower graph.* The number of control-mouse *LD*50 required to kill 50 per cent of the mice, when challenged with neuro-*WS* at various times after receiving receptor-destroying enzyme

Groups of 4–5 weeks old mice were inoculated in the right cerebral hemisphere with 12,000 units[6] of purified[7] receptor-destroying enzyme in 0·03 ml., two hours to twenty-two days before being challenged by intracerebral inoculation of neuro-*WS* into the right hemisphere. The times of receptor-destroying enzyme inoculations were so arranged that challenge occurred on the same day for all groups and could, therefore, consist of titrating a single neuro-*WS* allantoic fluid in each group of mice (four mice being used per 0·5 $\log_{10}$ dilution). The mice were observed for twelve days after challenge, at the end of which time all surviving mice appeared perfectly healthy. Protection was estimated by the degree of reduction in the titre[8] (*LD*50) of the neuro-*WS* from the level found in a comparable group of mice which had received no pre-treatment. Afterwards, it was shown that receptor-destroying enzyme which had previously been inactivated by heating at 70° C. for one hour had no protective action.

The above experiment was done in conjunction with a study of the destruction *in vivo*, by a similar dose of receptor-destroying enzyme, of brain inhibitor to heated Lee[9] hæmagglutinin. Hæmagglutinin-inhibitor was measured in saline suspensions of each cerebral hemisphere of four mice, at various intervals after inoculation with receptor-destroying enzyme, and the geometric mean of the titres for each side was compared with the geometric mean titre of thirty-two normal hemispheres. So that dissemination of the receptor-destroying enzyme throughout the brain should not be aided by the process of preparing the brain suspensions, all brains were heated at 62° C. for one hour before they were ground up and suspended in saline. Suitable control experiments had shown that this procedure resulted in adequate inactivation of receptor-destroying enzyme. It follows that the observed degree of inhibitor destruction (more than 99·6 per cent) must represent the proportion of brain inhibitor which is accessible to receptor-destroying enzyme inoculated intracerebrally.

The accompanying figure shows that approximately a hundred control-mouse *LD*50 were required to kill 50 per cent of the mice which had received receptor-destroying enzyme less than four days before challenge, and that susceptibility gradually returned after four days. The figure also shows that the same amount of receptor-destroying enzyme produced marked destruction of hæmagglutinin-inhibitor in both hemispheres; this destruction was greatest on the fourth day and was followed by a very gradual regeneration of inhibitor running roughly parallel to the return of susceptibility to infection.

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## Inhibitory Action of Artificial Light on the Sexual Season of the Ewe

Recent studies on photoperiodicity have been undertaken in an attempt to hasten the onset of the sexual season of sheep[1–4], to extend the lactation period in goats, to accelerate the onset of œstrus in thoroughbred mares and to advance or prolong the egg-production season in pheasants[5]. Attempts to inhibit the sexual season are of considerable importance in solving certain problems of refractoriness of the gonads in the physiology of reproduction. Yeates[3] has shown that the cessation of the sexual season of Suffolk sheep occurs after 14–16 weeks exposure to an increasing plane of artificial light.

Two series of experiments were carried out to inhibit the sexual season of the ewe by artificial light. During the hours of daylight, artificial light was not used; control animals were available and ochred vasectomized rams were used for detecting œstrus. The term 'latency of cessation' denotes the period elapsing from the start of light treatment to the date of the last œstrus exhibited.

(*A*) Grade Suffolk ewes were exposed to light continuously from November 1, 1950. They were previously running on pasture under natural conditions of daylight until their sexual season had reached its height (per cent œstrus = 100). The experimental ewes were experiencing œstrus regularly but came off season some eight weeks earlier than the control. The date of cessation in the experimental group ranged from January 4 to February 1, with a mean of January 21 (21 ± 1·7), while in the control group the end of season ranged from February 7 to April 20, with a mean of March 17 (76 ± 5·7). The latency of cessation in the experimental group was twelve weeks, and the control ewes came off season when the natural daylight length was twelve hours. The length of cycle (17·4 days), duration of œstrus (36 hr.) and the frequency of silent heat (5 per cent silent heats expressed as a percentage of the total number of heats theoretically possible) were not significantly different in experimental and control groups.

(*B*) Œstrous ewes of six pure breeds (Blackface Mountain, Border Leicester, Dorset Horn, Romney Marsh, Suffolk and Welsh Mountain) and of one first cross (W.M. × D.H.) were exposed to a constant daily ration of 16 hr. light : 8 hr. darkness (long days) starting on September 4. They were previously subjected to a constant daily ration of 8 hr. light : 16 hr. darkness (short days) for some twenty weeks. The latency of cessation ranged from 6 to 24 weeks, according to the breed. The Dorset Horn and its cross showed the longest latency of cessation, whereas the mountain breeds (Blackface Mountain, Border Leicester and Welsh Mountain) had the shortest, and in Suffolks it was nine weeks. The date of cessation of the sexual season was on an average fifteen weeks earlier than the control.

It is concluded that the previous light treatment may control the maintenance and the cessation of the sexual season; and that either the presence of darkness as such or the contrast stimuli of the change from light to darkness is essential for the continuation of the sexual season of the ewe. The latency of cessation is also controlled by other factors besides light. Breeds of sheep which originated near the tropics have a shorter time-lag reaction to light than those breeds which originated nearer the poles. It seems that younger animals are more readily influenced by artificial light than adults. Individual differences are also shown in the response to light. The time of the year at which the light treatment starts determines the latency of response. The previous light environment is an important factor due to the residual effect of light. Both the ratio and rhythm of light control the speed of the response.

The mechanism of the light-stimulating action on the gonads is believed to be via the hypophysial-portal system[6], while the mechanism of the light-inhibitory action has not yet been elucidated.

This work was carried out in the Animal Research Station, Cambridge, during study leave granted from Fouad I University, Egypt. Detailed results of experiment (*B*) will appear elsewhere. Thanks are due to Dr. John Hammond for providing facilities and for his continuous encouragement.

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## Control of Cauliflower Mosaic Virus

Caldwell and Prentice[1] emphasized in 1942 the value of seed-bed isolation in the control of cauliflower mosaic virus, which in Devon has seriously reduced yields of broccoli. Experimental work at this College has shown that infection in the seed-bed can still be the main cause of reduced yield, even when conditions favour extensive spread of virus in the field after planting.

Three varieties of broccoli, Extra Early, *A*6 and *B*1, were grown in two seed-beds, one adjacent to an infected seed broccoli crop and one half a mile from any *Brassica* crop. The seedlings were planted out in replicated plots. Although practically all the plants in the experiment developed virus symptoms before they were cut, an analysis of the results shows that plants from the isolated seed-bed gave both heavier yields and higher percentages of marketable heads. As no difference in varietal susceptibility was observed, the three varieties are treated together in the following table.

Comparison of Yields from the Two Seed-beds

| Seed-bed | Per cent of curds of diameter more than 2 in. across | Av. total yield per plot (lb.) |
|---|---|---|
| Isolated by ½ mile | 81 | 49·5 (s.e. ± 4·7) |
| Not isolated | 44 | 36 (s.e. ± 2·12) |

Fortnightly recordings of the plots showed that there was considerable variation in the expression of symptoms. Plants infected in the seed-bed developed vein-clearing followed by vein-banding symptoms[2], and secondary infections of a similar type were observed in the autumn. From December onwards,

increasing numbers of plants showed an additional symptom, consisting of a diffuse mottling of small pale-green circular spots or rings standing out in contrast to the dark leaf background, that developed rapidly in young leaves which had previously shown no symptoms. These spots are suggestive of those caused by cabbage ring spot virus on cauliflowers as described by K. M. Smith[3]; but cross-inoculations on to *Nicotiana* sp. have so far been negative, and no leaves have been observed in which the spots have later become necrotic. The mottling is therefore considered to be a further expression of cauliflower mosaic virus.

An experiment using a systemic insecticide, *bis*-(*bis*-dimethylamino-phosphonous) anhydride, to control the aphid vector *Brevicoryne brassicæ* alighting on seedlings from infected plants, showed that while this insecticide sprayed on to plants at a concentration of 0·3 per cent v/v gave an excellent control of the aphids, virus transmission was not inhibited. The experiment was carried out under optimum conditions for virus transmission.

Further work is now in progress.

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April 26.

[1] Caldwell, J., and Prentice, I. W., *Ann. App. Biol.*, **29**, 4, 374 (1942).
[2] Caldwell, J., and Prentice, I. W., *Ann. App. Biol.*, **29**, 4, 366 (1942).
[3] Smith, K. M., "Text Book of Plant Virus Diseases", 9 (1937).

## Relationship of Aphid Density to Altitude

The dispersal of small insects to high altitudes by convection and turbulence is known to produce an insect-density gradient in which density decreases with height[1,2]. The distribution has never been expressed mathematically; and since the insect population of the air varies considerably from hour to hour, and most of the observations at the different heights were made at different times, mathematical analysis would have yielded little of value.

This handicap has been overcome in recent work, and the mean aerial density of aphids has been measured simultaneously at different heights using traps attached to a barrage balloon cable. The observations were made at Cardington, Beds, in co-operation with the Research and Development Establishment, Ministry of Supply.

Between May 27 and October 8, 1948, trapping with tow-nets was done simultaneously at 50, 250, 500, 1,000, 1,500 and 2,000 ft. above the ground during 08.30–10.30, 11.30–13.30 and 14.30–16.30 B.S.T. on suitable days. The nets had opening and closing devices, trapping only at the correct altitudes and times. Aphid densities (numbers per $10^6$ cu. ft. of air) were estimated from the number of aphids caught and the run of wind through the nets[3]. Wind runs were measured with anemometers at 10, 250 and 2,000 ft., values at the remaining heights being estimated by interpolation[4]. Although tow-nets under-estimate density at wind-speeds below about 7 m.p.h., it is possible to make a correction for calm conditions[3,5], and Table 1 shows arithmetical mean density estimates with and without the correction; the two estimates probably encompass the truth.

Table 1. Aphid density/$10^6$ cu. ft.

| Height (ft.) | Arith. mean (density + 1) Corrected | Arith. mean (density + 1) Uncorrected | Mean log (density + 1) Corrected | Mean log (density + 1) Uncorrected | No. 2-hr. runs | Mean wind-speed (m.p.h.) |
|---|---|---|---|---|---|---|
| 50 | 1,584·0 | 161·9 | 2·02 | 1·78 | 49 | 7·2 |
| 250 | 851·9 | 99·7 | 1·92 | 1·64 | 49 | 7·5 |
| 500 | 67·7 | 26·0 | 1·40 | 1·29 | 49 | 8·8 |
| 1,000 | 12·3 | 9·1 | 0·87 | 0·84 | 47 | 11·1 |
| 1,500 | 8·7 | 6·5 | 0·77 | 0·75 | 46 | 12·9 |
| 2,000 | 4·9 | 4·6 | 0·56 | 0·57 | 48 | 14·4 |

The distribution at any time is determined by the net effect of upward transport by turbulence and downward transport by gravity and biological impulse. It is not helpful to ascribe to an aphid a terminal velocity of fall as it is not an inert particle; but it is possible to obtain an estimate of the rate at which it tends to return to earth—the 'mean clearance-rate'—from a simple extrapolation of turbulence theory known to hold near the ground.

If $\chi$ is the density at height $z$, and $\omega$ is the 'mean clearance-rate', then for a quasi-stationary state the balance equation is:

$$\omega\chi = -K\partial\chi/\partial z,$$

where $K$ is the turbulent transport coefficient. Rossby and Montgomery make $K = k_0 u_x z$ (see, for example, ref. 6, p. 247), where $k_0$ is von Kármán's constant (0·4) and $u_x$ is the shearing velocity near the ground $(\tau_0/\rho)^{1/2}$. Then for any two heights $z_1$ and $z_2$,

$$\chi_1/\chi_2 = (z_1/z_2)^{-\omega/k_0 u_x};$$

hence a graph of log $\chi$ against log $z$ should yield a straight line of slope $-\omega/k_0 u_x$. Fig. 1 shows the graphs for mean logarithmic density with corrected and uncorrected data, and the lines drawn are good fits down to 250 ft. Departures from the straight lines at lower heights could arise from: (i) sampling errors at the lower wind-speeds near the ground; (ii) an additional re-distribution factor representing the flight behaviour of living insects moving between air and terrestrial habitats; (iii) the source of supply being local and irregular, whereas the higher aphids will have come from larger and more remote areas—possibly biologically different—farther upwind; (iv) the velocity profile departing markedly from its theoretical shape.

From the straight lines, the values of $-\omega/k_0 u_x$ are $-1·2$ (uncorrected) and $-1·5$ (corrected): the order of magnitude of $u_x$ is known to be 15 cm./sec. at the measured mean wind-speed[7]; hence the 'mean clearance-rate' is equivalent to approximately 7 cm./sec. (uncorrected) or 9 cm./sec. (corrected). Both values are much lower than such crude estimates of terminal velocity of aphids as exist; for example, Wellington's curves[8].

During the normal evening decay of flight activity, aphids which are brought near to earth will alight; and if the estimated 'mean clearance-rate' is a measure of the speed of return in the much calmer evening conditions, then the aphids in the lowest 2,000 ft. of the atmosphere should have returned to very low altitudes or to the ground, on the average, in about two hours. This estimated rate of clearance fits in well with observation[3].

For single days and single samplings there are frequent wide variations from the mean distributions represented in Fig. 1.

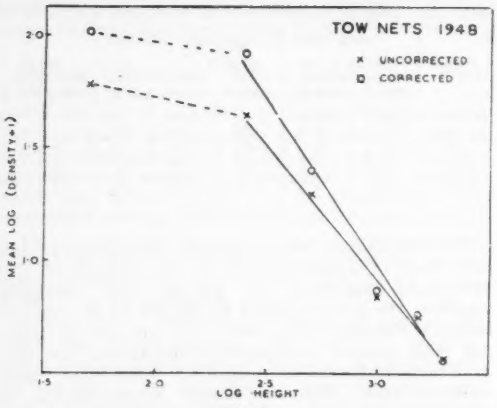


Fig. 1

In 1950 the work was repeated with suction traps, which are considered to be more reliable than tow-nets[3,5]; they were operated at 10, 150, 500 and 1,000 ft. The numbers of aphids caught per hour with each trap may be taken as the density for 132,000 cu. ft., since that volume of air is sampled by a trap in one hour irrespective of wind-speed. The results are scanty, for there were few aphids in 1950; but there are 65 separate hourly occasions between July 13 and 31 which can be used (Table 2). The average wind-speed was about the same as in 1949.

Table 2

| Height (ft.) | For 65 hours Total No. | For 65 hours Mean log (No. + 1) | For 7 hours Total No. | For 7 hours Mean log (No.) |
|---|---|---|---|---|
| 10 | 574 | 0·78 | 124 | 1·25 |
| 150 | 164 | 0·44 | 25 | 0·65 |
| 500 | 26 | 0·11 | 11 | 0·37 |
| 1,000 | 10 | 0·04 | 6 | 0·33 |

When mean log (catch + 1) is plotted against log (height) the points lie on a straight line between 10 and 1,000 ft., the slope being −0·4 (Fig. 2, lower curve); but there were too many occasions of zero catch at 1,000 ft. for the corresponding point on the graph to have any significance. There were, however, seven hours during which aphids were caught at all heights, and for these no adjustment was made before taking logarithms. The upper curve of Fig. 2 is for these results and has a slope of −0·5, from which the 'mean clearance-rate' is 3 cm./sec.

This changed estimate in clearance-rate may be the result of the change in trapping technique or of different degrees of validity of the simple assumption made in the analysis. As the work with suction traps is being extended, detailed examination of the meteorological factors will be postponed until more results are available.

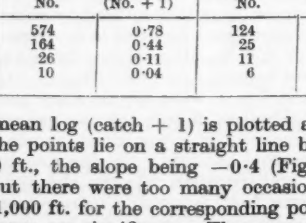


Fig. 2

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April 16.

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[2] Glick, P. A., U.S. Dept. Agric. Tech. Bull. No. 673, 150 (1939).
[3] Johnson, C. G., *Sci. Prog.*, **39**, 41 (1951).
[4] Taylor, G. I., *Proc. Roy. Soc.*, A, **92**, 196 (1916).
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## Chromosome Number and Chromosome Morphology in *Helicophyllum crassipes*

*Helicophyllum crassipes* (Araceæ)[1] grows as a weed in the coastal belt of Egypt, in localities where the soil is light calcareous sand and where the percentage of salt is low. It is a corm-geophyte which sprouts late in October and flowers during January and February; flowering sometimes extends through March and April. The plant seems to possess a high capacity for seed production.

Chromosome counts and study of chromosome morphology were made in squashes of root-tips and anthers. Feulgen and acetic-orcein methods were used. For pollen grain mitosis Allen–Bouin as fixative and crystal-violet-iodine were used. Pretreatment with 8-oxyquinoline[2] (0·002 mol. per litre for 4 hr.) was also used in root-tip preparations. Material was collected from plants growing naturally.

More than two hundred metaphase plates (polar view) showing clearly the number of chromosomes and their morphology were counted and studied. The accompanying drawings were made from specimens subjected to 8-oxyquinoline pretreatment, which shows the constrictions clearly. This effect is due to the shortening of the arms of the chromosomes and resulting elongation of the constrictions.

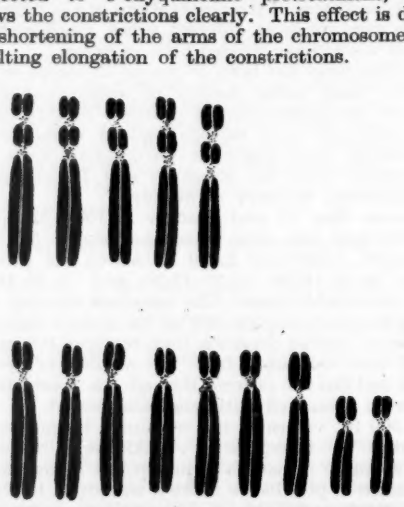

Fig. 1. Diagrammatic drawing of the chromosomes of *Helicophyllum crassipes* showing their comparative length and their constrictions

Fig. 2. Camera lucida drawing of a metaphase plate, polar view, using Leitz apochromatic objective, 90 ×, and compensating eyepiece 30 × (original magnification, 7,600 × ; reproduction, 2,500 ×)

In root-tips the diploid number was found to be 28. In every case it was possible to find a homologue for every chromosome, giving a definite count of 14 pairs.

The chromosomes were classified according to their morphology as : (1) chromosomes with two constrictions (primary and secondary) ; (2) chromosomes with a primary constriction only.

The primary constriction was invariably submedian in chromosomes with secondary constrictions, whereas in chromosomes with one constriction only it was subtelomeric. No chromosomes with strictly median or strictly telomeric primary constriction were noticed.

The chromosomes were also classified according to their length into long and short ones. Those with two constrictions were almost all long, except one pair which was slightly shorter than the rest. Those with a primary constriction only were also of the long type, except two pairs which were distinctly shorter (Figs. 1 and 2). The number of chromosomes with two constrictions is five ; with one constriction only, nine.

In some nuclei a small, almost spherical chromatin body (staining like the chromosomes) was noticed. No explanation can yet be given as to the origin and occurrence of this body.

Polyploid nuclei with chromosome number higher than $2n$ were occasionally noticed ; in a few cases the number was found to be 56, that is, tetraploid.

In pollen grains, mitosis takes place early when the grains are still young and before the thickening of the exine. Chromosome counts were 14. The chromosomes were found to agree in morphology with those of diploid cells in root-tips.

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[1] "A Manual Flora of Egypt", 1 (Berlin, R. Friedlaender und Sohn, 1912).
[2] Tjio, J. H., and Levan, A., *An. Estac. Exp. De Aula Dei*, Spain, 2 (1) (1950).

## Nitrogen Nutrition of Clover

VIRTANEN and collaborators[1,2] and Ghosh and Burris[3] have shown under aseptic conditions that red clover is able to make good growth when supplied with combined nitrogen in certain organic forms (for example, several amino-acids). Virtanen and von Hausen[1] reported, however, that white clover grew poorly on organic nitrogen. The finding that these closely related plants differed radically in their nitrogen requirements is of theoretical and practical interest, and has been further investigated by us.

Non-nodulated plants of red and of white clover (*Trifolium pratense* L. and *T. repens* L., respectively) were grown from seed entirely enclosed in test-tubes (8 in. × 1½ in. in size) plugged with cotton wool and containing an agar rooting-medium made up to the nitrogen-free formula of Chen and Thornton[4]. To this basal medium various forms of nitrogen were added in amounts representing 170 mgm. of nitrogen per litre of medium, the *p*H being adjusted to 6·5. All precautions were taken to secure asepticity in the cultures, the degree of achievement of this being judged chiefly by visual inspection of the agar medium during the course of the experiments. Very few cultures had to be discarded because of contamination.

| Form of nitrogen supplied | Red clover | | White clover | |
|---|---|---|---|---|
| | Increment in dry wt.* | Increment in nitrogen content* | Increment in dry wt.* | Increment in nitrogen content* |
| Ammon. nitrate | 64 | 3·9 | 79 | 4·4 |
| Ammon. sulphate | 66 | 3·0 | 78 | 3·9 |
| Potas. nitrate | 64 | 3·2 | 53 | 2·9 |
| *l*-Asparagine | 78 | 4·5 | 90 | 4·6 |
| *l*-Aspartic acid | 27 | 1·9 | 90 | 3·3 |

* Mean increases (in mgm. per tube) over the corresponding values for control tubes (no combined nitrogen added) which were as follows (again as mgm. per tube) : dry weight 61 (red), 35 (white) ; nitrogen content 1·0 (red), 0·6 (white). Each tube-culture contained 4–7 plants of red or 6–9 plants of white clover, with 8 tubes for each treatment, and 6·3 mgm. combined nitrogen was originally added to the agar medium of each tube.

After ten weeks growth under summer conditions, the dry weight (by heating at 95° C.) and total nitrogen were found for the plants from each tube. The results of the main experiment are presented in the accompanying table. Statistical analysis confirms that in both clovers the dry weight of plants receiving asparagine was significantly higher (at $P = 0{\cdot}05$) than that attained with inorganic nitrogen, while in white clover the same applies to aspartic acid. Similar analysis of the results for nitrogen content shows that asparagine was absorbed as readily as (in white clover) or more readily than (in red clover) the most freely absorbed form of inorganic nitrogen, namely, ammonium nitrate.

These results fail to confirm that white clover is inferior to red in its ability to utilize organic nitrogen, and, in fact, tend in the opposite direction. The reasons for this and other divergences from the findings of Virtanen and von Hausen[1] are not immediately obvious, and may not be revealed until fuller study of the conditions affecting uptake of organic nitrogen by plants has been made. Meanwhile, it appears doubtful whether there is any major difference in the nitrogen requirements of the two clovers.

This question is relevant to studies such as those of Bond and McGonagle[5], where non-nodulated plants of different species of clover were grown as standards against which the effectiveness of different strains of the nodule organism in fixation of atmospheric

nitrogen was assessed. In future work of that type it is probable that an organic compound such as asparagine could with advantage be provided as the source of nitrogen for the standard plants.

The above experimental work was carried out while one of us (J. T. V.) was holding a British Council scholarship.

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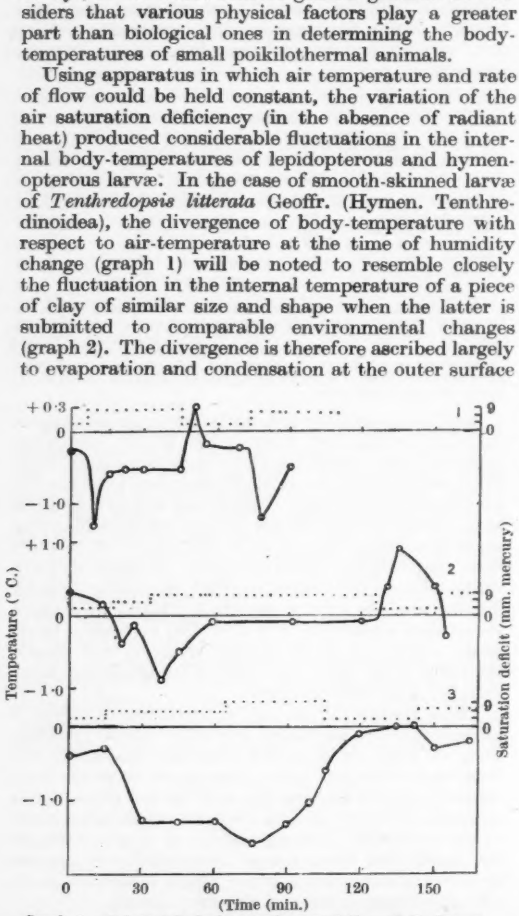
## Body-Temperature of Small Insect Larvæ

Laboratory experiments carried out in the autumn of 1950 appear to support remarks made by Dr. D. A. Parry[1], to the effect that on general grounds he considers that various physical factors play a greater part than biological ones in determining the body-temperatures of small poikilothermal animals.

Using apparatus in which air temperature and rate of flow could be held constant, the variation of the air saturation deficiency (in the absence of radiant heat) produced considerable fluctuations in the internal body-temperatures of lepidopterous and hymenopterous larvæ. In the case of smooth-skinned larvæ of *Tenthredopsis litterata* Geoffr. (Hymen. Tenthredinoidea), the divergence of body-temperature with respect to air-temperature at the time of humidity change (graph 1) will be noted to resemble closely the fluctuation in the internal temperature of a piece of clay of similar size and shape when the latter is submitted to comparable environmental changes (graph 2). The divergence is therefore ascribed largely to evaporation and condensation at the outer surface




Graph 1. Internal body-temperature variation of *T. litterata* Geoffr. (weight 0·06 gm.)
Graph 2. Internal temperature of a piece of clay
Graph 3. Internal body-temperature of *M. rubi* (weight 2·5 gm.) Solid curves: internal temperature-difference of larva or clay with respect to an air temperature of 20° C. Dotted lines: saturation deficiency of air in mm. of mercury

of the larval integument, rather than to a mechanism involving gain or loss of internal fluids. This latter process can scarcely be the means in the case of the clay model; nor is it clear, in the case of the larva, that gain of internal water can occur quickly enough to produce the abrupt rise in temperature. This interpretation is emphasized by a comparison of the curves at such times as the environmental conditions were steady, when the clay is seen to return almost to air-temperature, whereas the larval temperature is depressed slightly below this level, presumably due to the thermal effects resulting from the loss of internal body-fluids not present in the model.

Thus while the depression of larval body-temperature below that of the surrounding atmosphere may be at all times in part due to the loss of internal fluids, the major portion of the effect at moments of humidity change is the result of surface phenomena.

Further information with regard to surface evaporation and condensation is provided by an experiment with a 2·5 gm. caterpillar of the fox moth (*Macrothylacia rubi*). The integument of this larva is densely setose and presumably capable of harbouring more moisture than that of a smooth-skinned form. For this reason an extended period of body-temperature depression due to the evaporation of surface moisture might be expected to follow atmospheric humidity change. Reference to graph 3 shows such a state of affairs to exist and a considerable depression to be maintained for some time, after which a slow return to a temperature approaching that of the air might be interpreted as due to the conductive heating effects of the surrounding atmosphere. Had this extended depression been due solely to a loss of internal fluid, which was finally almost completely exhausted, this animal might have been expected to show signs of desiccation; this was not the case. Furthermore, a return to conditions of evaporation, after a period in a moist atmosphere, resulted in a small but steady depression of body-temperature, denoting a continuous loss of fluid, which might be expected if now only internal fluid were being evaporated via some restricted aperture or region. This reinforces the suggestion that the initial extended depression was due mostly to loss of external surface moisture, which was finally almost completely exhausted, so that a short intervening period in a humid atmosphere was insufficient to restore its abundance.

Further details of this work and the methods involved, together with evidence of the importance of considering (*a*) the previous history of insects with regard to surface moisture, and (*b*) the nature and proximity of surfaces on which they may be supported, when making body-temperature observations, will be published elsewhere.

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Dundee. April 30.

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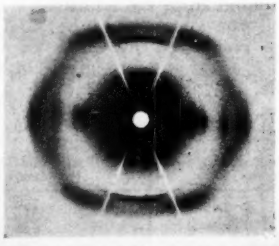
## Structure of Synthetic Polypeptides and Proteins

In a recent series of papers, Pauling, Corey and Branson[1] and Pauling and Corey[2a-g] have proposed structures for synthetic polypeptides and proteins based on helical configurations of the molecules, and have claimed that these account for the X-ray results of Bamford, Hanby and Happey[3] on the polypeptides,

and for the X-ray photographs of a number of proteins. It is the purpose of this communication to indicate that, in fact, the unit cells of Pauling and Corey are unsatisfactory for at least two of the three polypeptides which have been studied in detail, and probably also for α-keratin. Comments on the structures of Pauling and Corey, and these authors' objections to the $\alpha_{II}$-fold, will be reserved for a later paper from these Laboratories.

The X-ray data on poly-γ-benzyl-L-glutamate are interpreted in terms of a helical structure containing 11 amino-acid residues in three turns and a pseudo-orthorhombic unit cell with $a_0 = 25$ A., $b_0 = 17{\cdot}3$ A. (fibre axis), $c_0 = 14{\cdot}42$ A., and $\beta = 90°$ [2b]. The near meridional reflexions at 5·27 A., which are a striking feature of the diagram[2], are indexed by Pauling and Corey as (131) (230). The inclination of the normal to these planes to the *b*-axis is 24° 30′, and it may readily be shown that the corresponding reflexions in a fibre diagram should subtend a semi-angle $\chi$ at the centre of the diagram of approximately 23°. The observed value of $\chi$ from Fig. 3 of the paper by Bamford, Hanby and Happey[3] (upon which the American authors base their unit cell) is about 10°. This diagram was obtained with a film of polymer, the X-ray beam passing through one edge, and it might be considered that the difference between the two $\chi$-values could be explained by double orientation of the molecules. This is not satisfactory, however. In a photograph taken with the beam normal to the film, the 5·27-A. reflexions are not resolved and appear as a polar arc. The equatorial reflexions in this photograph are also drawn out into arcs, showing that although the molecules lie mainly in the plane of the film, their orientation about the direction of stretching is not particularly high. Even so, the polar arc subtends a semi-angle of only 18°. A similar result is obtained from an X-ray photograph of the same film rotated about the direction of stretching (see photograph). Here again the polar reflexions are not resolved, and the polar arc is too short to permit a value of $\chi$ as great as 23°. The radial lines on the photograph correspond to $\chi = 23°$ and are obviously outside the main polar reflexion. (For purposes of comparison, the centres of the reflexions on the first hyperbola of the X-ray diagram of poly-γ-methyl-L-glutamate given in Fig. 1 of ref. 3 subtend an angle of 26° 50′. A comparison will show the very considerable difference between these reflexions and the polar reflexion of the accompanying photograph.) A comparison of the dispersions of the strong equatorial reflexions and the polar arc at 5·27 A. shows that the normal to the planes giving rise to the latter are inclined at about 10° to the fibre axis. Similarly, it may be shown that the other three reflexions on the hyperbola (4·48 A., 4·05 A. and 3·60 A.) are too near the meridian to correspond to Pauling and Corey's unit cell, although the diffuse nature of the reflexions makes this point more difficult to demonstrate.



X-ray photograph of oriented film of poly-γ-benzyl-L-glutamate. Film rotated about axis of orientation, which was vertical. Copper *Kα* radiation, *D* = 4 cm.

The same results can, of course, be obtained from reciprocal lattice considerations.

For these reasons we believe that the repeat (or submultiple) along the fibre axis is smaller than that used by Pauling and Corey (5·76 A., that is, $b_0/3$), and is close to 5·45 A., as suggested by Bamford, Hanby and Happey[3]. We conclude that the particular helical structure and unit cell proposed are not consistent with the X-ray data.

The same conclusion applies in the case of the 1 : 1 copolymer of DL-β-phenylalanine and DL-leucine. It has been shown[4] that in the X-ray diagram of highly oriented fibres of this copolymer, the 5·35-A. reflexion is resolved into two near meridional spots, with $\chi = 11°\ 4'$. This again is significantly smaller than the value (23°) calculated from Pauling and Corey's fibre repeat of 5·75 A., indicating that the latter is too large. The correct value calculated from $\chi = 11°\ 4'$ is 5·51 A.

Thus, the three synthetic polypeptides γ-methyl- and γ-benzyl-L-glutamates, and the copolymer of DL-β-phenylalanine and DL-leucine, have fibre repeats (or submultiples) close to 5·45 A., in excellent agreement with the $\alpha_{II}$-structure.

We feel that the structure proposed for α-keratin[2e], based on a helix with 3·7 residues per turn, and a fibre repeat of 5·65 A. can be criticized on similar grounds. The corresponding value of $\chi$ for the 5·15-A. reflexion is 24° 30′; the total length of the polar arc in porcupine quill corresponds only to $\chi = 15°$.

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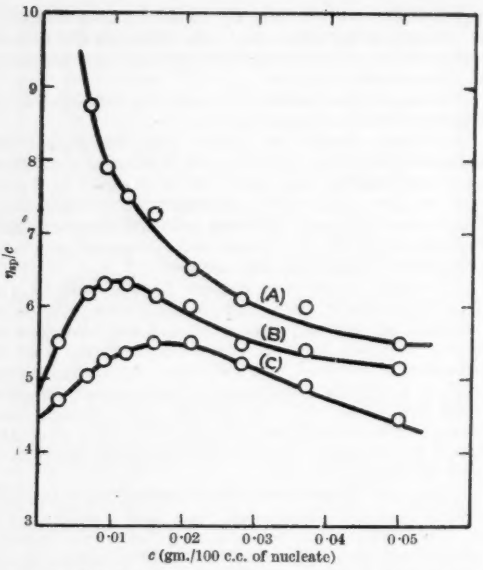
[2] (*a*) Pauling and Corey, *Proc. U.S. Nat. Acad. Sci.*, **37**, 235 (1951); (*b*) *ibid.*, 241; (*c*) *ibid.*, 251; (*d*) *ibid.*, 256; (*e*), *ibid.*, 261; (*f*) *ibid.*, 272; (*g*) *ibid.*, 282.
[3] Bamford, Hanby and Happey, *Proc. Roy. Soc.*, A, **205**, 30 (1951).
[4] Bamford, Hanby and Happey, *Proc. Roy. Soc.*, A, **206**, 407 (1951).

## Viscosity of Sodium Thymonucleate

THE viscosity of sodium thymonucleate solutions shows some peculiar characteristics. There is considerable reduction in viscosity of a dilute solution of sodium thymonucleate in presence of neutral salts and alkali. Greenstein and Jenrette[1], as also Tennent and Vilbrandt[2], have postulated the reversible depolymerization of the nucleic acid molecule in presence of neutral salt and alkali. From the measurement of dissymmetry by the light-scattering method, Smith and Sheffer[3] have shown that the nucleic acid molecules coil up in solution in presence of neutral salts. The peculiar viscosity effect may similarly be attributed to coiling and uncoiling of the molecules rather than to reversible depolymerization in presence of salt. Since nucleic acid is a long-chain molecule with the acid groups distributed along the chain, it is to be expected that the sodium salt of the acid will behave as a polyelectrolyte, according to Fuoss's contention[4], in solution, and the peculiar viscosity characteristics may be explained on the assumption of a coiling-uncoiling effect with the extent of dissociation. Viscosity measurements of sodium thymonucleate solution have been under-




taken in this laboratory, and it will be evident from the accompanying graph that the reduced viscosity ($\eta_{sp}/c$) increases as the solution is diluted, a result contrary to that for neutral polymers and similar to that of polyelectrolytes.

This phenomenon may be explained as follows. As the solution is diluted, more and more of the sodium salt dissociates and consequently the number of charge-centres on the chain increases. The mutual repulsion of similarly charged centres causes the chain to assume a more and more stretched out configuration with increasing dissociation, that is, with diminishing concentration of thymonucleate, and hence leads to higher reduced viscosity at lower dilution. This hypothesis may be tested by an experiment which it suggests. When a simple one-one electrolyte, sodium chloride, is added to a solution of sodium thymonucleate, we should expect that by a simple mass action effect, under the influence of Coulomb attraction, some of the sodium ions would be drawn back on the polymer chain, that is, the thymonucleate molecule will be less dissociated. When the concentration of sodium chloride is sufficiently high, almost the whole of the dissolved molecules will be undissociated over a considerable range of concentration and will behave like a neutral polymer. This is why Tennent and Vilbrandt[5] obtained a linear curve for reduced viscosity/concentration for sodium thymonucleate solution in presence of 1 per cent sodium chloride. When, however, the concentration of sodium chloride is much lower, sodium thymonucleate molecules will be completely undissociated and behave like a neutral polymer below a particular concentration of thymonucleate; above this concentration, some of the electrolyte groups will undergo dissociation and behave as polyelectrolytes. The reduced viscosity will, therefore, increase with concentration of thymonucleate. Curves *B* and *C* support this view; in presence of sodium chloride, the curves show a hump, the maximum of which occurs at a concentration of thymonucleate where the concentration of sodium ion from thymonucleate is nearly equivalent to that from added sodium chloride. At $3{\cdot}1 \times 10^{-4}$ gm. equivalent of sodium chloride the maximum is at 0·01 per cent or $2{\cdot}8 \times 10^{-4}$ gm equivalent of thymonucleate (curve *B*), while at $5{\cdot}3 \times 10^{-4}$ gm. equivalent of sodium chloride the maximum is at 0·0175 per cent or $4{\cdot}9 \times 10^{-4}$ gm. equivalent of thymonucleate (curve *C*).

Sadhan Basu
Indian Association for the Cultivation of Science,
Calcutta 32.
March 20.

[1] Greenstein and Jenrette, *J. Nat. Cancer Inst.*, **1**, 77 (1940).
[2] Tennent and Vilbrandt, *J. Amer. Chem. Soc.*, **65**, 1806 (1943).
[3] Smith and Sheffer, *Canad. J. Research*, **28**, 96 (1950).
[4] Fuoss, *Science*, **108**, 545 (1948).
[5] Tennent and Vilbrandt, *J. Amer. Chem. Soc.*, **65**, 424 (1943).

## Effect of Shear's Polysaccharide on Plasma Clotting

One of the agents most effective in causing regression of tumours is the polysaccharide which Shear and his associates were able, some years ago, to extract from the bacterium *Serratia marcescens*[1]. This polysaccharide causes a high percentage of regression in the tumours of mice, but unfortunately it is rather toxic for human beings. If more were known as to the exact nature of the polysaccharide, it might be possible to find other compounds similar in their action on tumours, but less toxic.

Heilbrunn and Wilson[2] have suggested that the polysaccharide behaves like heparin in preventing the division of cells; they have suggested that the polysaccharide may be a compound related to heparin. In cells generally, the initiation of mitosis is accompanied by a sharp increase in protoplasmic viscosity, the mitotic gelation, which is thought of as a protoplasmic clotting. Heparin prevents this clotting; so, too, do dilute solutions of the bacterial polysaccharide[3].

Is the bacterial polysaccharide of Shear perhaps a heparin or a heparin-like substance? Heilbrunn and Wilson[3] have found that it gives a metachromatic reaction with toluidine blue; this is a positive test for heparins. Information as to the effect of the bacterial polysaccharide upon blood clotting was sought in the following manner. Polysaccharide *P*-25, containing 36 mgm. per c.c. (I am indebted to Dr. M. J. Shear for kindly supplying a sample of the polysaccharide to the laboratory), was diluted with distilled water. Freshly oxalated human plasma was employed as the substrate, 1 c.c. of 0·1 *M* sodium oxalate being added to 9 c.c. of blood. Clotting time determinations were run at 37° C., in standard tubes, upon a total volume of 0·3 c.c. (one-third plasma, one-third polysaccharide in distilled water or distilled water control, one-third 0·025 *M* calcium chloride). Time was counted from the addition of the calcium chloride until the tubes could be safely inverted. Results were calculated in terms of the control (exp./control × 100), and are given in the accompanying table.

Effect of Shear's Polysaccharide on Plasma Clotting

| Polysaccharide (per cent) | Plasma clotting time (per cent control) |
|---|---|
| 3·6 | 750 |
| 1·8 | 240 |
| 1·44 | 188 |
| 1·08 | 158 |
| 0·72 | 130 |
| 0·36 | 115 |

Shear's polysaccharide was shown by this method to inhibit the clotting of recalcified plasma; its effect is therefore heparin-like. Comparison with various commercial heparin preparations showed them to be approximately 138–320 times more effective.

This investigation was aided by a grant from the U.S. Public Health Service, administered by Prof. L. V. Heilbrunn.

SYLVIA MOST

Department of Zoology,
University of Pennsylvania,
Philadelphia. April 18.

[1] Shear, M. J., and Turner, F. C., *J. Nat. Cancer Inst.*, **4**, 81 (1943). Hartwell, J. L., Shear, M. J., and Adams, J. R., *ibid.*, **4**, 107 (1943).
[2] Heilbrunn, L. V., and Wilson, W. L., *Proc. Soc. Exp. Biol. and Med.*, **70**, 179 (1949).
[3] Heilbrunn, L. V., and Wilson, W. L., *Science*, **112**, 56 (1950); *Protoplasma*, **39**, 389 (1950).

## Surface Tension of Liquid Metals

Atterton and Hoar's[1] communication recalls two papers recently published on this subject. Schytil[2] has shown that the surface-tension $\sigma$ is related to the melting point $T_m$ and the atomic volume $V$ by

$$\sigma = K_1 T_m V^{-2/3}, \qquad (1)$$

where $K_1$ is a constant. The other paper, due to Auerbach[3], contains data to show that, for a considerable number of substances, including metals and even liquid helium,

$$\sigma = K_2 \rho v^{2/3}, \qquad (2)$$

where $\rho$ is the density of, and $v$ the velocity of sound in, the substance, $K_2$ being another constant. As Schytil points out, expression (1) can be converted to one similar to that due to Wen Po[4]:

$$\sigma = K_3 A \nu_D^2, \qquad (3)$$

where $A$ is the atomic weight, $\nu_D$ the Debye frequency, and $K_3$ another constant.

If we postulate (*a*) that the cube of the transverse velocity, $c_t$, is small as compared with that of the longitudinal velocity, $c_l$, or (*b*) that in many cases there is a linear relation between the two[5], Debye's expression for the number of oscillators assumes the form:

$$V \nu_D^3 = K_4 v^3, \qquad (4)$$

where $V$ is the atomic volume and $K_4$ a constant. Combining (4) with (2) and introducing the Debye temperature $\theta_D$ instead of the frequency $\nu_D$,

$$\sigma^2 = K_5 A \rho \theta_D^3 = K_5 p, \qquad (5)$$

where $K_5$ is a constant.

In order to reveal the discrepancies for small values of $p$, it is better to plot the logarithms of both sides of this equation. The values of $\rho$ are taken from the International Critical Tables; those for $\theta_D$ are given by Seitz[6]. The data for $\sigma$ are obtained from Atterton and Hoar's graph and from the International Critical Tables. They refer to temperatures at or near the melting point. It will be seen that the semi-empirical expression (5) is fairly successful in several instances. If the linearity of the data is compared with that to be expected from equation (3), it will be realized that there is little to choose between the two. The lines have slopes equal to unity: it would seem that slopes somewhat smaller than this would provide a better fit for each set of points. The best-fitting straight lines calculated from the regression coefficients have slopes of 0·861 and 0·856 corresponding to equations (3) and (5) respectively; they are not inconsistent with the theoretical values of unity. The fact that both expressions (3) and (5) are roughly satisfied is probably due to the inaccuracy of the experimental data, and also suggests that the empirical expression (2) is only another form of the one due to Wen Po[4].

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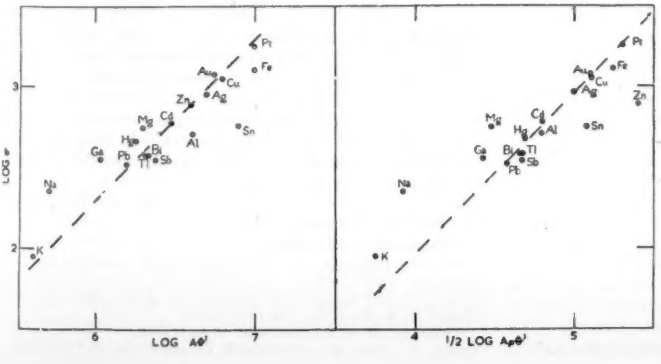
May 7.

[1] Atterton and Hoar, *Nature*, **167**, 602 (1951).
[2] Schytil, *Z. Naturforsch*, A, **4**, 191 (1949).
[3] Auerbach, *Experientia*, **4**, 473 (1948).
[4] Wen Po, *Phil. Mag.*, **23**, 33 (1937).
[5] Joos, "Theoretical Physics".
[6] Seitz, "Modern Theory of Solids".

IN a communication in *Nature* of April 14, Messrs. Atterton and Hoar recorded the conclusion that "surface tension is approximately inversely proportional to atomic volume". May I venture to recall that this is a conclusion which I put forward some thirty-seven years ago, based upon determinations of the surface tensions of some of the commoner metals, which I had made at the Royal Mint, by measuring the depths of depressions in carbon tubes of small bore[1]. By plotting the reciprocals of the surface tensions of these metals against their atomic weights and side by side with their atomic volumes, the resemblance to Lothar Meyer's well-known curve became apparent. The resemblance was even closer when these reciprocals were plotted side by side with atomic volumes raised to the 2/3 power[2]. I felt justified, therefore, in suggesting that the surface tensions of molten metals, like other properties, are periodic functions of their atomic weights and that they vary inversely as some function of their atomic volumes. Now that figures for the surface tensions of more elements are available, it is satisfactory to find that Messrs. Atterton and Hoar have arrived at the same conclusion.




The implication of this relationship with regard to the penetration of liquid metals into compacted sand, to which they refer in the latter part of their communication, has, I think, some analogy to the

behaviour of metals on the surfaces of cupels when undergoing cupellation in the process by which gold bullion is assayed. When the surface tension of the metal is lowered by the presence of tellurium, I have shown that the 'cupellation losses', normally allowed for by suitable 'checks', may, in extreme cases, be such that complete absorption of the metal by the cupel may occur[3].

S. W. Smith

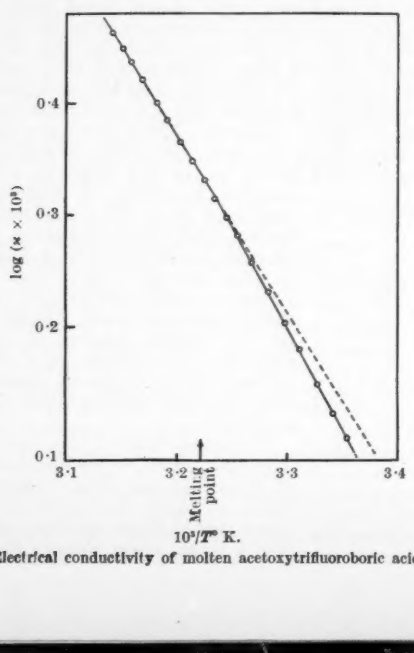
7 De Vere Gardens,
London, W.8.
June 2.

[1] *J. Inst. Metals*, **12**, No. 2, 168 (1914).
[2] *J. Inst. Metals*, **12**, No. 2, 205 (1914).
[3] *Trans. Inst. Min. and Metal.*, 463 (1908).

## Discontinuities in Supercooled Ionic Melts

During the course of a systematic investigation on the electrochemistry of boron trifluoride co-ordination compounds[1], discontinuities were observed in the temperature variation of viscosity on passing from the normal liquid to the supercooled state. In both temperature regions the viscosity could be expressed by an exponential relation of the form $\eta = \eta_0 \exp(B/RT)$, but the activation energy $B$ was approximately 10 per cent greater for the supercooled state. The temperature coefficient of the specific volume ($v$) shows no such discontinuity at the melting point, and this fact may be used for emphasizing the discontinuous behaviour of the viscosity by the application of Batchinski's equation[2] $\eta = C/(v-b)$, where $C$ and $B$ are constants. For example, if the fluidity $\varphi = 1/\eta$ is plotted as a function of specific volume for acetoxytrifluoroboric acid, $H[CH_3.CO.OBF_3]$, there is a well-defined discontinuity at a point corresponding to the melting point, 37·5° C. The change in slope is 34 per cent, compared with an increase of 10 per cent for the activation energy $B$ for this compound.

As boron trifluoride complexes are systems for which the activation energies of ionic migration are very similar to those of viscous flow[3,4], it is likely that similar configurational changes occur in the two processes and that ionic mobility at various temperatures will be proportional to the viscosity. It might therefore be expected that the specific conductivity of such liquids would show a corresponding effect at the melting point. This is, in fact, the case, as may be seen from the accompanying graph, in which $\log \varkappa$ is plotted against $1/T$ for molten acetoxytrifluoroboric acid. The increase in slope at the melting point is 13 per cent. A graph of specific conductivity as a function of specific volume shows the same phenomenon.




Electrical conductivity of molten acetoxytrifluoroboric acid

The ionic compounds formed by boron trifluoride with methyl, ethyl, *n*-propyl and *n*-butyl acetates behave in a precisely analogous fashion to the addition compound with acetic acid considered above. The effect, however, is not confined to ionic melts, as Dodd and Hu Pak Mi[5] have shown that plots of $\log \eta$ against $1/T$ for phenyl ether and *m*-chloronitrobenzene are discontinuous at the melting point. It is consequently of interest to determine whether or not these effects are general in supercooled melts. The data on such systems are rather scattered, but a recalculation of available information shows that the same trend is implicit in the figures of Walden, Ulich and Birr[6] for the viscosity and conductivity of certain molten picrates.

A fuller discussion will be published elsewhere.

N. N. Greenwood
R. L. Martin

University Chemical Laboratory,
Cambridge.
April 6.

[1] Greenwood, N. N., and Martin, R. L., *J. Chem. Soc.* (in the press).
[2] Batchinski, A. J., *Z. phys. Chem.*, **84**, 643 (1913).
[3] Greenwood, N. N., Martin, R. L., and Emeléus, H. J., *J. Chem. Soc.*, 3030 (1950).
[4] Greenwood, N. N., and Martin, R. L., *J. Chem. Soc.* (in the press).
[5] Dodd, C., and Hu Pak Mi, *Proc. Phys. Soc.*, B, **65**, 454 (1949).
[6] Walden, P., Ulich, H., and Birr, E. J., *Z. phys. Chem.*, **131**, 1 and 21 (1927).

## Dimensions of the Nitrite Ion

As part of a programme of X-ray investigations of N—O bond-lengths and angles, and in particular for comparison of the bond-lengths in the positive (nitronium)[1] and negative (nitrite) $NO_2$ ions, the structure of sodium nitrite[2] has been redetermined.

Three-dimensional and differential Fourier syntheses (corrected for termination of series errors) give the following dimensions for the nitrite ion :

| | | |
|---|---|---|
| Bond-length | N—O | 1·13(9) A. |
| Angle | O—N—O | 132° 48′ |

The root mean square error in the bond-length calculated by the method of Cruickshank[3] is ±0·01 A., so that the value of 1·14 A. now found is not significantly different from the value of 1·15 A. for O—N in the nitronium ion in nitrogen pentoxide[4].

Full details of the determination will be published together with those for nitronium perchlorate, which is still under investigation.

M. R. Truter

Chemistry Department,
University of Leeds.
July 25.

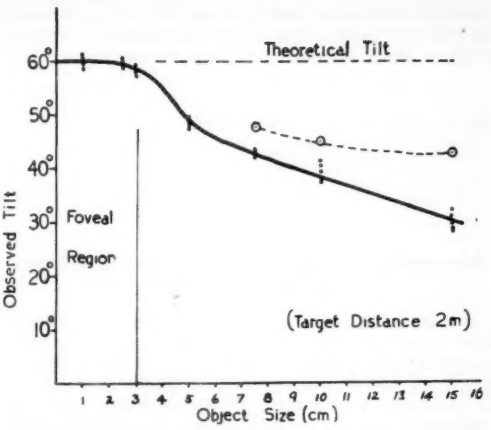
[1] Cox, E. G., Jeffrey, G. A., and Truter, M. R., *Nature*, **162**, 259 (1948).
[2] Ziegler, G. E., *Phys. Rev.*, **38**, 1040 (1931).
[3] Cruickshank, D. W. J., *Acta Cryst.*, **2**, 65 (1949).
[4] Grison, E., Eriks, K., and Vries, J. L., *Acta Cryst.*, **3**, 290 (1950).

## Ocular Scanning and Depth Perception

THE relation between peripheral and foveal vision and the extent to which scanning movements of the eyes are necessary in the perception of three-dimensional space are problems of long standing. Experimental work on stereoscopic vision has been largely concerned with the measurement of stereoscopic acuity, using the three-needle test or one of its modifications, under carefully controlled conditions. Such tests give the minimum resolvable difference in depth which can be perceived by an observer under the given conditions; but they do not explain how the eyes function when they view the normal three-dimensional world. In normal observation of space the point of fixation ranges over a wide field, and the eyes are continuously receiving dissimilar uniocular impressions. It is generally assumed, however, that stereoscopic vision is based upon the stimulation of disparate retinal points, so that consequent on the presentation of unequal uniocular impressions the final perceptual pattern in space is determined by the retinal disparity from purely geometrical considerations. The experiments which are to be described show that this simple geometrical theory does not hold generally, but only if the space object forms an image entirely on the fovea.

A modified form of Wheatstone stereoscope was used to examine and measure the observed stereoscopic effects which resulted from given retinal image disparities. The two unequal uniocular impressions were obtained by using horizontally disposed arrows as targets in the stereoscope. Black arrows on white backgrounds, of equal illumination, were used as targets, the arrows being of equal thickness but of slightly different length. Each arrow was viewed by one eye alone, and the two fused impressions gave a perceptual image directly in front of the observer. This perceptual image was a horizontal arrow tilted out of the subject's frontal plane. The mirrors of the stereoscope were semi-transparent to allow observation of an indicator arrow, mounted on a divided circle, and placed coincident with the perceptual image. By aligning the indicator arrow with the perceptual image, the position and angle of tilt of the latter were determined. Except where otherwise stated, the subject viewed the two arrows with complete freedom of eye movement and with as much time as he required to make the alignment.

Several series of pairs of targets were used, all the pairs in a series having the same percentage difference in length but different mean length. The mean lengths and target distance were such that the angular subtense at the eye varied from 4° to 0·75°. The fovea subtends an angle of about 1°. With targets of angular subtense 4° the observed tilt was very much less than the theoretical value, that is, less than the value determined from the simple geometrical consideration mentioned in the first paragraph. Reduction in the angular subtense of the targets reduced the discrepancy between the observed and theoretical tilts until the images were entirely foveal, when the difference between the observed and theoretical tilts vanished. The full line on the graph shows, for one observer and for one series of targets, the variations in the observed tilt with the variation of angular subtense of the targets. The percentage size differences in the targets were such as to give a theoretical tilt of 60°. The observer had no detectable eye faults and was considered to have normal vision. Other observers with normal vision produced similar results.




If the targets were large, the eyes of the observer were seen to make continuous scanning movements back and forth along the targets. When these scanning movements were suppressed, by compelling the observer to maintain fixation of a small mark placed at the centre of one of the arrows, the perceptual images ceased to display any stereoscopic qualities and no tilt was observed. Again, in other experiments, small marks were placed beyond each end of one of the arrows and the observer was asked to make voluntary oscillations of the fixation point between the two marks. This artificial extension of the amplitude of scanning caused the observed angle of tilt (shown in the broken line on the graph) to be increased, although the increased tilt was still much smaller than the theoretical value. Both the increase in the angle of tilt under such extended scanning, and the tilts observed for large targets under normal scanning, were found to vary from individual to individual.

It is rather surprising that the graph of the observed tilt against angular subtense is a smooth curve. So far, no explanation for this variation of tilt with increasing peripheral imagery can be offered; but it should be mentioned that the conditions of observation in the experiment are to a certain extent unreal. The objects observed, which are the images of the targets in the stereoscope mirrors, lie in the observer's frontal plane. Hence, the variations in vergence during scanning are very much smaller than the variations which occur when an object tilted out of the subject's frontal plane is observed in normal vision.

From the results, however, it is fairly clear that two separate processes are involved in our perception of space. If we observe limited fields the images of which are formed entirely on the fovea, our stereoscopic appreciation of space is governed entirely by retinal image disparity. But if the objects are larger —and they usually are in everyday life—the simple geometrical picture breaks down and the stereoscopic effects depend not only on retinal image disparity but also on the extent of field observed. In such extended field vision the experiments appear to show that space perception is achieved largely by the ranging or scanning of the field by the eyes. Such a scanning process can very probably be considered to be one of learning or experience, since extra-foveal spatial perception becomes much more accurate when consciously practised. The differences between

observers then arise partly from differences in training but also quite probably from anomalies of various kinds in the binocular visual mechanism.

J. Adamson

Department of Natural Philosophy,
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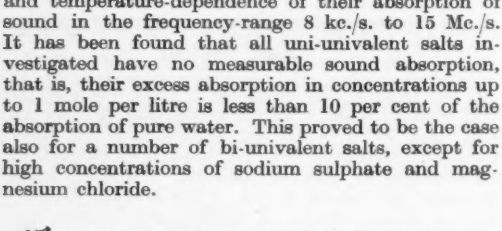
St. Andrews.
April 16.

## Absorption of Sound in Aqueous Solutions of Electrolytes

A large number of aqueous solutions of electrolytes have been investigated for frequency-, concentration- and temperature-dependence of their absorption of sound in the frequency-range 8 kc./s. to 15 Mc./s. It has been found that all uni-univalent salts investigated have no measurable sound absorption, that is, their excess absorption in concentrations up to 1 mole per litre is less than 10 per cent of the absorption of pure water. This proved to be the case also for a number of bi-univalent salts, except for high concentrations of sodium sulphate and magnesium chloride.




Absorption coefficient of a 0·02 $N$ magnesium sulphate solution × wave-length ($2\alpha.\lambda$) *vs.* frequency

○, Measured by resonance method; ×, measured by reverberation method; ●, measured in progressive waves

The bi-bivalent sulphates examined (magnesium, manganese, copper, zinc, cobalt and nickel salts), on the contrary, showed very great absorption, which, from the slope of the frequency response, must be due to a relaxation process[1]. For example, the frequency response of the absorption of a 0·02 $N$ magnesium sulphate solution is given in the accompanying graph, where $2\alpha.\lambda$ is plotted as a function of frequency. These parameters give a typical relaxation curve with a maximum at 120 kc./s. Other sulphates show similar curves, the relaxation frequencies of which are somewhat higher (for example, manganese, copper, zinc and cobalt sulphates), or lower (for example, nickel sulphate). The dependence on concentration from 0·002 to 0·2 mole per litre for magnesium sulphate proved to be linear within the limits of accuracy of measurement, that is, there is a constant absorption effect or absorption cross-section per molecule. Although this result is opposite to the expectation of Liebermann[1], who assumed an increase of the absorption cross-section proportional to the square root of the concentration, we believe that the relaxation process must be due to an interaction between the ions similar to that assumed by Liebermann. In favour of this are the changes of absorption observed in mixing different salts. In particular, we found the following rule for mixtures of magnesium sulphate and sodium chloride. The decrease of absorption observed when sodium chloride is added to a magnesium sulphate solution can be explained by the loss of some of the ion-pairs of the magnesium sulphate through interaction with the sodium chloride, which therefore cause no absorption in this frequency-range. The remainder of the magnesium sulphate concentration still effective in absorption is given by:

$$C_{\text{eff}} = [MgSO_4]\,\frac{[MgSO_4]}{[MgSO_4] + f.\,[NaCl]}\;;\quad f = 1/5.$$

The factor $f = 1/5$ can be explained by the difference in interaction between 2-2- and 2-1-valent pairs of ions.

The further increase of absorption[2] above 5 Mc./s. is also remarkable. From its frequency response, it seems to be due to another relaxation process, caused by a change in the hydration shells of the reacting ions. The dependence of frequency response and the amount of absorption on concentration and temperature are in accord with this view.

The measurements were made with different methods in successive frequency-ranges, since any one method is only applicable in a limited frequency-range of about 1 decade.

In the range 8–50 kc./s., the absorption of the solution was determined from the decay constant of a single natural vibration of the solution in a spherical glass vessel with thin walls[3]. The losses of the walls were eliminated by comparison with the decay constant of pure water, measured at the same natural frequency. The absorption of pure water was assumed to be given by

$$2\alpha/f^2 = 50 \times 10^{-17}\ \text{cm.}^{-1}\text{sec.}^2,$$

the value which is obtained at higher frequencies.

In the range from 50 kc./s. to 1 Mc./s., a statistical reverberation method according to Meyer and Skudrzyk[4] has been applied, using a 100-litre aluminium vessel. With this method a mean value of the decay constants of many natural vibrations is measured, within a band-width of ± 10 kc./s. The losses at the walls here, too, are eliminated by comparison with determinations using pure water.

In the frequency-range 3–15 Mc./s., the absorption was determined from the difference of level of the sound intensity in a plane progressive wave at two different distances from the source. This difference was obtained by photometrical comparison of the diffraction loss of the zero-order light of two beams of light crossing the sound field. The absorption determined for pure water by this method differs up to 10 per cent from the above-mentioned value. The excess absorption of magnesium sulphate as given in the graph is only of the same magnitude as the absorption of pure water in this frequency-range.

K. Tamm
G. Kurtze

III. Physikalisches Institut,
Universität,
Göttingen.
April 30.

[1] Liebermann, L., *Phys. Rev.*, **76**, 1520 (1949).
[2] Smith, M. C., Barrett, R. E., and Beyer, R. T., *J. Acous. Soc. Amer.*, **23**, 71 (1951).
[3] Cf. Leonard, L., *J. Acous. Soc. Amer.*, **18**, 252 (1946).
[4] Skudrzyk, E., *Oestr. Ing. Arch.*, **4**, 408 (1950). Mulders, C. E., *App. Sci. Res.*, B, **1**, 341 (1949).

# FORTHCOMING EVENTS

## Wednesday, August 29—Saturday, September 8

EIGHTEENTH NATIONAL RADIO AND TELEVISION EXHIBITION (at Earls Court, London, S.W.5).

## Thursday, August 30—Thursday, September 13

ENGINEERING, MARINE AND WELDING EXHIBITION (at Olympia, Hammersmith Road, London, W.14).

# APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned :

ASSISTANT TEACHER IN THE DEPARTMENT OF PHARMACY AND BIOLOGY—The Registrar, College of Technology, Suffolk Street, Birmingham 1 (September 1).

DEMONSTRATOR (temporary) IN BOTANY—The Secretary and Registrar, University College of North Wales, Bangor (September 1).

STATISTICIANS (with a university degree in statistics or in mathematics, economics or other appropriate main subject, combined with statistics, with at least second-class honours or equivalent) in the Board of Trade, London—The London Appointments Office, Ministry of Labour and National Service, 1–6 Tavistock Square, London, W.C.1, quoting JN.129 (September 6).

CIVIL ENGINEER on the staff of the Chief Mechanical and Electrical Engineer in the Production Department at London headquarters—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, endorsed TT/365 (September 8).

ENGINEERS I at a Ministry of Supply establishment in London : (Ref. C.486/51A) to be responsible for planning and production, including preparation of plant layout, or either fuses, igniters, primers and all ancillaries for all types of ammunition, (Ref. C.487/51A) for small arms ammunition, including filling, (Ref. C.488/51A) with experience in methods of planning, sufficient to control a section responsible for the compilation and critical analysis of production and repair requirements for airframes, engines and associate equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (September 8).

ENGINEERS, MATHEMATICIANS or PHYSICISTS (Senior Scientific Officer grade) at a Ministry of Supply Experimental Aircraft Establishment in southern England, for research work in connexion with aircraft flight testing—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.221/51A (September 8).

LECTURER IN PHYSIOLOGY, and an ASSISTANT IN MATHEMATICS—The Secretary, The University, Edinburgh (September 8).

PHYSICISTS and ENGINEERS (Experimental Officer grade) at the Atomic Energy Research Establishment, Harwell, to take charge of the Electrical Standards Laboratory—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.234/51A (September 8).

PSYCHOLOGICAL TESTERS IN H.M. Prison and Borstal Service at Birmingham, Bristol, Durham, Liverpool and London—The Establishment Officer (E.84/4/7), Prison Commission, Dean Ryle Street, London, S.W.1 (September 8).

SCIENTIFIC OFFICERS or SENIOR SCIENTIFIC OFFICERS at the National Physical Laboratory for work in physics, mechanical engineering, metallurgy, radio and naval architecture—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.222/51A (September 8).

SENIOR ENGINEER, DESIGN SECTION, Dominion Physical Laboratory, Department of Scientific and Industrial Research, Lower Hutt, New Zealand—The High Commissioner for New Zealand, 415 Strand, London, W.C.2 (September 10).

SENIOR ASSISTANTS (Scientific) : CHEMISTS experienced in analytical work, for the testing and analysis of soils, feeding-stuffs, fertilizers, milk, etc., BACTERIOLOGISTS experienced in laboratory routine, BIOLOGISTS experienced in the routine of a general biological laboratory, and specialized in either plant pathology or entomology and microscopy, BIOCHEMIST with knowledge of hygiene and pathology and ability to assist in teaching in these fields, BIOCHEMIST with sound knowledge and experience in nutritional work, CHEMICAL ENGINEER for supervisory duties, ELECTRONICS ENGINEER with specialized knowledge of Post Office relays—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4054/51LA (September 13).

ASSISTANT LECTURER or LECTURER IN CIVIL ENGINEERING at Gordon Memorial College, Khartoum—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (September 15).

LECTURER IN AGRICULTURAL BOTANY—The Registrar, King's College, Newcastle-upon-Tyne (September 15).

LECTURER IN MINERAL DRESSING AND ASSAYING in the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (September 15).

PRINCIPAL RESEARCH OFFICER or SENIOR RESEARCH OFFICER (Ref. No. 3510), to lead a scientific unit that will include a geologist, geomorphologist, pedologist and ecologist, to carry out surveys in Papua and New Guinea, organize the assembly of existing information and co-ordinate the work of the several specialists in the unit, a SENIOR RESEARCH OFFICER or RESEARCH OFFICER (Ecologist) (Ref. No. 3511), to serve as plant ecologist to the unit, and a SENIOR RESEARCH OFFICER or RESEARCH OFFICER (Geomorphologist) (Ref. No. 3512), to make special studies in the field of geomorphology, and act in general co-ordination with the geologist and pedologist—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (September 15).

SCIENTISTS, Grade II (with good honours degrees or equivalent qualifications in science or engineering, and some previous research experience) at London headquarters, to assist in the formulation and progressing of research programmes—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, endorsed TT/366 (September 15).

SOIL CONSERVATION OFFICERS in the Department of Conservation and Extension, Southern Rhodesia—The Secretary, Office of the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (September 15).

ELECTRONIC ENGINEERS in Ministry of Supply establishments in southern England, for the design of radio and/or radar components, equipment and installations (including aerials) and engineering of prototypes for production—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting D.359/51A (September 17).

FORESTRY INSPECTOR (Grade III, established), and a FORESTER Grade III, unestablished)—The Secretary, Civil Service Commission, (5 Upper O'Connell Street, Dublin (September 20).

CIVIL and MECHANICAL ENGINEERS at Ministry of Supply research and development establishments in London, Glasgow, Farnborough, Christchurch, Salisbury and St. Helens, for design, development and installation work in the structural and plant engineering fields—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting C.485/51A (September 22).

ENGINEER I at a Ministry of Supply establishment at Salisbury, to be responsible for the design, erection, calibration and final testing of chemical plants—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting C.228/51A (September 22).

ENGINEERS I in Ministry of Supply establishments in London and the Provinces for (*a*) factory production management on gun carriages and tanks, ammunition, small arms, filling ; (*b*) development of maintenance and services work in filling and explosives factories ; (*c*) various Headquarters posts on production planning and progressing, or on maintenance, services, plant installation, etc.—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting C.472/51A (September 22).

ELECTRONIC ENGINEERS in the Ministry of Supply, to work near London or at provincial stations on the development and design of electrically operated systems for a variety of applications including weapons, telecommunications and radar equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting D.134/51A (September 24).

LECTURER IN DAIRY HUSBANDRY at Massey Agricultural College (University of New Zealand), Palmerston North—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (September 25).

PHARMACOLOGIST to the Alfred Hospital, Prahran, Melbourne—The Agent General for Victoria, Victoria House, Melbourne Place, Strand, London, W.C.2 (September 29).

LECTURER IN NUTRITION at the School of Home Science, University of Otago, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (September 30).

PROFESSOR OF ANATOMY—The Registrar, University College, Cathay's Park, Cardiff (September 30).

PROFESSIONAL ENGINEERS, General Service Class (Main and Senior grades), in Government Departments—The Secretary, Civil Service Commission, Trinidad House, Old Burlington Street, London, W.1, quoting S.86/51 (October 1).

DIRECTOR OF THE GEOLOGICAL SURVEY, Department of Industry and Commerce, Dublin—The Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin (October 18).

ASSISTANT BIOCHEMIST in the Department of Pathology—The Secretary, Bolton and District Hospital Management Committee, Royal Infirmary, Bolton.

ASSISTANT LECTURER IN PHYSICS—The Registrar, The University, Nottingham.

BIOCHEMIST, to direct and carry out work in intermediary metabolism and in problems of enzyme inhibition—Box No. 23, Ottawa, Ontario, Canada, quoting Competition No. G-18.

B.L.M.R.A. FELLOWSHIP, for research in the Leather Industries Department, University of Leeds under the direction of Prof. D. Burton, and a JUNIOR SCIENTIFIC OFFICER (with a good honours degree and, preferably, some knowledge of chemical engineering) to work in the chemical engineering section—The Director of Research, British Leather Manufacturers' Research Association, Milton Park, Egham, Surrey.

CHEMISTS or ENGINEERS (3), to visit members' works in all parts of the British Isles—The Director, British Launderers' Research Association Laboratories, Hill View Gardens, London, N.W.4.

HONOURS GRADUATE IN PHYSICS, to teach physics up to general B.Sc. standard, together with some mathematics up to Inter.B.Sc. standard—The Principal, Gloucester Technical College, Brunswick Road, Gloucester.

PHYSICIST (honours degree in physics and some research experience essential) to take charge of the South Wales Laboratory in Swansea—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

POSTGRADUATE ASSISTANT in connexion with work on Nuclear Physics—The Clerk, Birkbeck College, Breams Buildings, London, E.C.4.

PROFESSOR AND HEAD OF THE DEPARTMENT OF ELECTRICAL ENGINEERING (Heavy), Indian Institute of Technology, Kharghpur—The Ministry of Labour and National Service, Technical and Scientific Register (A.8.12), York House, Kingsway, London, W.C.2, quoting A.12/UNE/150/51.

PROFESSORS (2, one of whom should have special qualifications in applied thermodynamics) IN THE FACULTY OF MECHANICAL ENGINEERING, at the Technion (Institute of Technology), Haifa, Israel—The Secretary, The Technion Society of Great Britain, 13 Mansfield Street, London, W.1.

SENIOR LECTURER, and a LECTURER, IN PHYSICS, at the Bradford Technical College—The Director of Education, Town Hall, Bradford.

SENIOR SCIENTIFIC OFFICERS and SCIENTIFIC OFFICERS in various Government departments and covering a wide range of scientific research and development in most of the major fields of fundamental and applied science—The Secretary, Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. 3399.

TEACHER OF PHARMACOLOGY (of professorial grade), and a PHARMACEUTICAL CHEMIST, at the Hardinge Medical College, New Delhi—The Secretary (Division 5A), Ministry of Health, Savile Row, London, W.1.

# REPORTS and other PUBLICATIONS

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## Great Britain and Ireland

Ministry of Health and Scottish Office. Inland Water Survey Committee: Fifth Annual Report, 1950. Pp. 20. (London: H.M. Stationery Office, 1951.) 9*d*. net. [256

British School of Archæology at Athens. Annual Report of the Managing Committee for the Session 1949–1950; Archæology in Greece, 1949–1950, by J. M. Cook. Pp. 52. (London: British School of Archæology at Athens, 1951.) [256

British Standard 1711: 1951, Solid Rubber Flooring. Pp. 12. 2*s*. net. British Standard 1741: 1951, Methods for the Chemical Analysis of Liquid Milk. Pp. 14. 2*s*. net. British Standard 1742: 1951, Methods for the Chemical Analysis of Condensed Milk. Pp. 20. 2*s*. 6*d*. net. British Standard 1743: 1951, Methods for the Chemical Analysis of Dried Milk. Pp. 12. 2*s*. net. (London: British Standards Institution, 1951.) [256

Ministry of Local Government and Planning. District Heating Working Party: Interim Report. Pp. 16. (London: H.M. Stationery Office, 1951.) 6*d*. net. [256

Cost and Performance Comparisons within an Industry. By K. Marshall. Pp. 17. (London: British Institute of Management, 1951.) 2*s*. [266

Report of the Astronomer Royal to the Board of Visitors of the Royal Greenwich Observatory read at the Annual Visitation of the Royal Observatory, 1951 June 2. Pp. ii+29. (Greenwich: Royal Observatory, 1951.) [276

Medical Research Council of Ireland. Annual Report for the Year ended December 31, 1950. Pp. 39. (Dublin: Medical Research Council of Ireland, 1951.) [27

Wye College: Department of Hop Research. Annual Report, 1950. Pp. 84. (Wye: Wye College, 1951.) 4*s*. [27

East Malling Research Station. Annual Report, 1st October 1949 to 30th September 1950. Pp. 219+33 plates. (East Malling: East Malling Research Station, 1951.) 10*s*. [27

Functions of a Personnel Department. By G. R. Moxon. Pp. 36. (London: Institute of Personnel Management, 1951.) 3*s*. [37

City of Leicester Museum and Art Gallery. Forty-fourth Report to the City Council, 1st April 1949 to 31st March 1950. Pp. 36. (Leicester: Museum and Art Gallery, 1951.) [37

Department of Scientific and Industrial Research: Road Research Laboratory. Road Research Technical Paper No. 22: Bituminous Roads in North America; Research and Construction. By Dr. A. R. Lee. Pp. vi+28+20 plates. (London: H.M. Stationery Office, 1951.) 2*s*. 6*d*. net. [37

Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences. No. 627, Vol. 235: A Contribution to the Study of the Eocene in Western Pakistan and Western India, B, The Description of the Lamellibranchia from Standard Sections in the Rakhi Nala and Zinda Pir Areas of the Western Punjab and in the Kohat District. By F. E. Eames. Pp. 311–482+plates 9–17. (London: Cambridge University Press, 1951.) 50*s*. [47

British Empire Cancer Campaign. Twenty-eighth Annual Report covering the Year 1950. Edited by Sir Heneage Ogilvie. Pp. 394. (London: British Empire Cancer Campaign, 1951.) [47

Annual Report on the Progress of Rubber Technology. Edited by Dr. T. J. Drakeley. (Published for the Institution of the Rubber Industry.) Vol. 14, 1950. Pp. vi+115. (Cambridge: W. Heffer and Sons, Ltd., 1951.) 21*s*. [97

Colonial Office. The Processing of Colonial Raw Materials; a Study in Location. By Dr. Charlotte Leubuscher. Pp. iv+186. (London: H.M. Stationery Office, 1951.) 10*s*. net. [97

Report on the Work of the Tin Research Institute, 1950. Pp. 32. (Greenford: Tin Research Institute, 1951.) [97

British Coal Utilisation Research Association. Annual Report, 1950. Pp. 42. (Leatherhead: British Coal Utilisation Research Association, 1951.) [97

Medical Research Council. The Application of Scientific Methods to Industrial and Service Medicine. Proceedings of a Conference held from March 29th to March 31st, 1950. Pp. 112. (London: H.M. Stationery Office, 1951.) 3*s*. net. [97

Fourth Empire Mining and Metallurgical Congress held in Great Britain, July 9th–23rd, 1949. Proceedings. Edited by F. Higham. Part 1. Pp. xx+552. Part 2. Pp. xx+553–1140. (London: Empire Mining and Metallurgical Congress, 1950.) [97

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 868, Vol. 243: The Aberrations of Magnetic Electron Lenses due to Asymmetries. By P. A. Sturrock. Pp. 387–429. (London: Cambridge University Press, 1951.) 10*s*. [107

University of Reading: National Institute for Research in Dairying. Report, 1950. Pp. 103. (Shinfield: National Institute for Research in Dairying, 1951.) 3*s*. [117

Central Office of Information: The Social Survey. Children Out of School: an Inquiry into the Leisure Interests and Activities of Children Out of School Hours carried out for the Central Advisory Council for Education (England) in November–December 1947. By Joy C. Ward. Pp. ii+76. (London: The Social Survey, 1951.) 10*s*. [117

## Other Countries

Research Council of Alberta. Report No. 58: The Components of the Bitumen in Athabasca Bituminous Sand and their Significance in the Hot Water Separation Process. By D. S. Pasternack and K. A. Clark. Pp. 14. (Edmonton, Alba.: King's Printer, 1951.) 15 cents. [256

Western Australia. Report of the Director of Government Chemical Laboratories for the Year 1948. Pp. 34. (Perth: Government Printer, 1950.) [258

Commonwealth Scientific and Industrial Research Organization. Bulletin No. 254: Physical Measurement of Quality in Canning Peas. By L. J. Lynch and R. S. Mitchell. Pp. 35+2 plates. (Melbourne: Government Printer, 1950.) [256

Kongelige Danske Videnskabernes Selskab, Matematisk-fysiske Meddelelser. Bind 26, Nr. 5: The Total Charges of Fission Fragments in Gaseous and Solid Stopping Media. By N. O. Lassen. Pp. 28. (København: Ejnar Munksgaard, 1951.) 3 kr.; 4*s*.; 75 cents. [256

New Zealand Forest Service. Information Series No. 11: Forest Taxation in Europe and New Zealand; a Critical Examination of the New Zealand Tax System. By M. B. Grainger. Pp. 108. (Wellington: Government Printer, 1950.) [270

Canada: Department of Mines and Technical Surveys: Geological Survey of Canada. Bulletin 18: Contributions to the Palæontology and Stratigraphy of the Jurassic System in Canada. By Hans Frebold. Pp. vi+54. 25 cents. Bulletin 19: The Correlation, by Petrographic Analyses, of No. 5 Seam in the St. Rose and Chimney Corner Coalfields, Inverness County, Cape Breton Island, Nova Scotia. By P. A. Hacquebard. Pp. v+34. 25 cents. (Ottawa: King's Printer, 1951.) [27

Victoria University College Zoology Publications. No. 7: A Study of the Marine Spiny Crayfish *Jasus lalandii* (Milne-Edwards), including Accounts of Autonomy and Autospasy. By C. A. Bradstock. Pp. 38. No. 8: Keys and Bibliography to the Collembola. By J. T. Salmon. Pp. 82. Nos. 9 and 10: Blood Parasites of Mammals in New Zealand, by Dr. Marshall Laird: A Contribution to the Study of Fijian Hæmatozoa, with Descriptions of a New Species from each of the Genera Hæmogregarina and Microfilaria, by Dr. Marshall Laird. Pp. 14+15. (Wellington: Victoria University College, 1950–1951.) [27

Union of South Africa: Department of Commerce and Industries: Fisheries and Marine Biological Survey Division. Investigational Report No. 12: An Introduction to the Hydrology of South African Waters. By A. J. Clowes. Pp. 42+20 charts. (Pretoria: Government Printer, 1950.) [27

Smithsonian Miscellaneous Collections. Vol. 116, No. 6: A New Species of the Jurassic Brachiopod Genus *Septirhynchia*. By Helen M. Muir-Wood and G. Arthur Cooper. (Publication 4047.) Pp. ii+6+2 plates. (Washington, D.C.: Smithsonian Institution, 1951.) [27

United Nations: Department of Public Information. United Nations Work and Programs for Technical Assistance. Pp. 40. 15 cents; 1*s*. World Facts and Figures. Pp. 36. 25 cents; 1*s*. 9*d*. (New York: United Nations; London: H.M. Stationery Office, 1951.) [27

East African Industrial Research Board. Eighth Annual Report, 1950. Pp. 16. (Nairobi: East African Industrial Research Board, 1951.) [37

Annals of the New York Academy of Sciences. Vol. 54, Art. 2. Papain. By M. L. Tainter and 12 other Authors. Pp. 143–296. (New York: New York Academy of Sciences, 1951.) 3 dollars. [37

Reviews of Pure and Applied Chemistry. (Quarterly.) Vol. 1, No. 1, March. Pp. 52. (Melbourne: Royal Australian Chemical Institute, 1951.) 7*s*. 6*d*.; annual subscription, 25*s*. [4

Mémoirs de l'Institut d'Etudes Centrafricaines. No. 3: Étude historique sur les Mpongoues et tribus avoisinantes. Par Rév. P. Gautier. Pp. 71. (Brazzaville: Institut d'Étude Centrafricaines, 1950.) 300 francs. [5

Kungl. Fiskeristyrelsens Fyrakeppsundersökning. År 1948–1949. Pp. 104. (Göteborg: Elanders Boktryckeri A.-B., 1951.) [9

Institut Royal Météorologique de Belgique. Mémoires, Vol. 45. Un nouvel électromètre portatif pour la mesure des charges électrostatiques par système électronique; son application à la mesure du potentiel atmosphérique et à la radiosonde. Par L. Koenigsfeld et Ph. Piraux. Pp. 21+4 plates. Mémoires, Vol. 46: Précision des sondages aérologiques; contribution à l'étude des résultats expérimentaux de la comparaison de six types de sondes-Payerne, Mai 1950. Par L. Malet. Pp. 24. Miscellanées, Fasc. 42: Considérations sur la distribution du magnétisme terrestre en Belgique. Par Edmond Hoge. Pp. 8. (Uccle: Institut Royal Météorologique de Belgique, 1951.) [9

Service de la Pêche et de la Chasse en Indochinie. Communications présentées aux 1re et 2e Sessions du Conseil Indo-Pacifique des Pêches, Singapour 1949–Cronulla 1950. Pp. 115. (Phnom-Penh: Service de la Pêche et de la Chasse en Indochinie, 1950.) [9

South African Institute for Medical Research. Annual Report for the Year ended 31st December 1950. Pp. 91. (Johannesburg: South African Institute for Medical Research, 1951.) [9

Transactions of the American Philosophical Society. New Series. Vol. 41, Part 2: Shaftesbury and the Deist Manifesto. By Prof. Alfred Owen Aldridge. Pp. 295–386. (Philadelphia: American Philosophical Society, 1951.) 1.50 dollars. [9

Memorie dell'Istituto Lombardo di Scienze e Lettere. Vol. 25, Fasc. 2: Studi di mitologia Mediterranea ed Omerica. Memoria del Prof. Giovanni Patroni. Pp. 13–91. (Milano: Ulrico Hoepli, 1951.) [9

National Administration and International Organization: a Comparative Survey of Fourteen Countries. Report of an Inquiry conducted jointly by the International Institute of Administrative Sciences and Unesco. Pp. 78. (Paris: Unesco; London: H.M. Stationery Office, 1951.) 150 francs; 3*s*.; 50 cents. [9

Bulletin of the National Research Council. No. 122: Proceedings of the Alaskan Science Conference of the National Academy of Sciences National Research Council, Washington, November 9–11, 1950. Pp. x+216. (Washington, D.C.: National Academy of Sciences, 1951.) 2 dollars. [9

'Scicong' Memoranda for Unesco. Pp. iv+59. (Calcutta: Indian Science Congress Association, 1951.) [10

East Africa High Commission: East Africa Medical Survey. Annual Report, 1950. Pp. ii+41. (Nairobi: East Africa High Commission, 1951.) [10